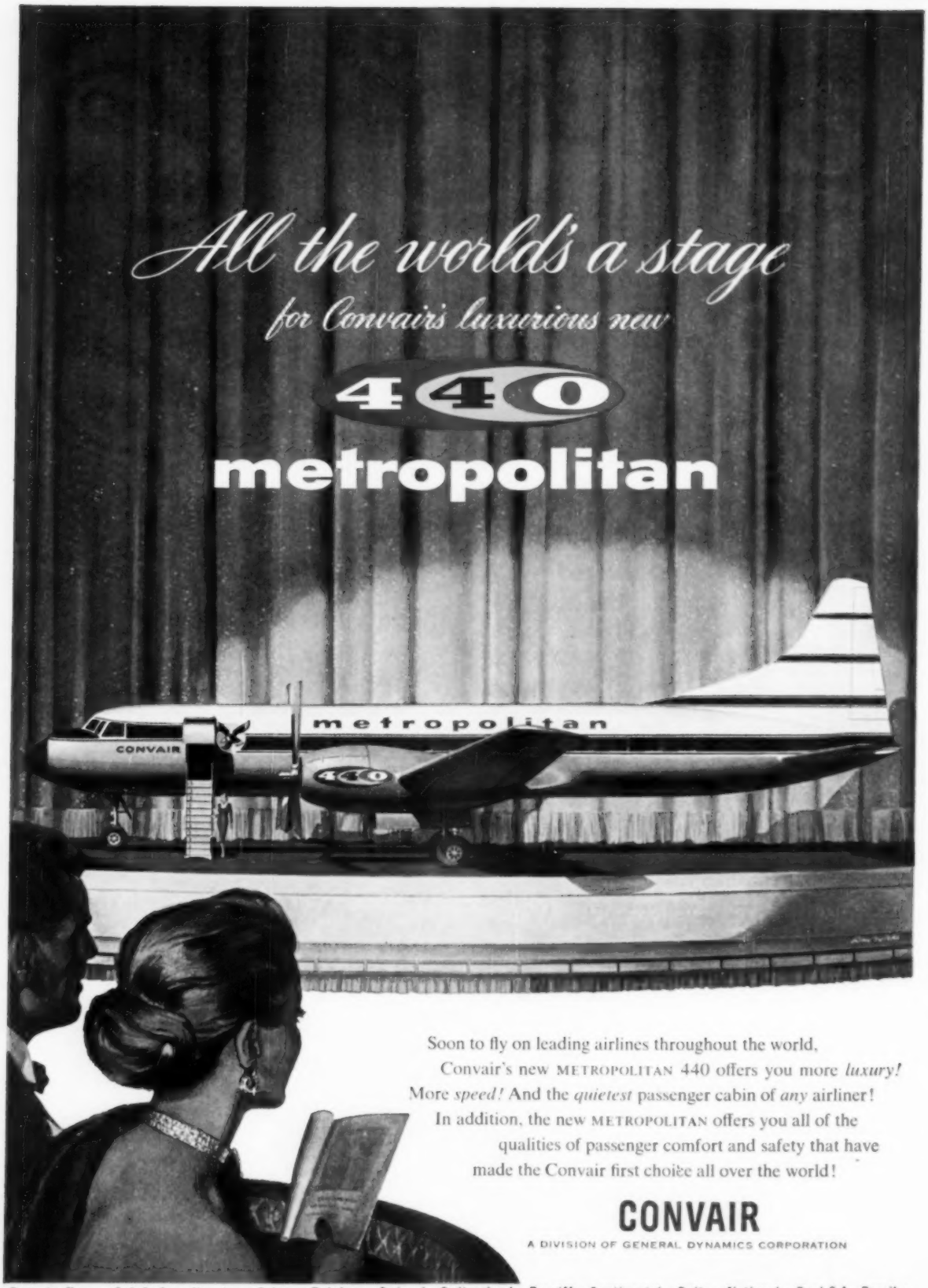
MARCH 12, 1956

AVIATION WEEK

A McGRAW-HILL PUBLICATION

23rd Annual Inventory of Airpower

Airpower in the Atomic Deadlock



Soon to fly on leading airlines throughout the world, Convair's new METROPOLITAN 440 offers you more *luxury!* More *speed!* And the *quietest* passenger cabin of *any* airliner! In addition, the new METROPOLITAN offers you all of the qualities of passenger comfort and safety that have made the Convair first choice all over the world!

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A DIVISION OF GENERAL DYNAMICS CORPORATION

Soon to fly on: S•A•S, Scandinavian • Sabena, Belgium • Swissair, Switzerland • Braniff • Continental • Delta • National • Real S.A., Brazil • Aero O/Y, Finland • Alitalia, Italy • LACSA, Costa Rica • Iberia, Spain • LAI, Italy

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Maximum load-carrying capacity and workhorse durability are just two of the many reasons why the Fairchild C-123 Assault Transport is ideally suited to tough jobs in all combat airlift operations.

Equipped with Fairchild J44 turbojets on each wing-tip, the C-123 is provided with a power package of 2,000 lbs. extra thrust to meet any critical take-off or flight requirement.

In front line operations, on any terrain, under the most difficult conditions, the Fairchild C-123 gives *big load, big lift,* and *big performance* where and when utility and logistics support is needed.

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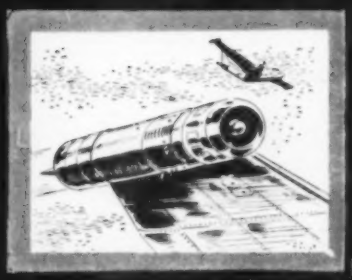
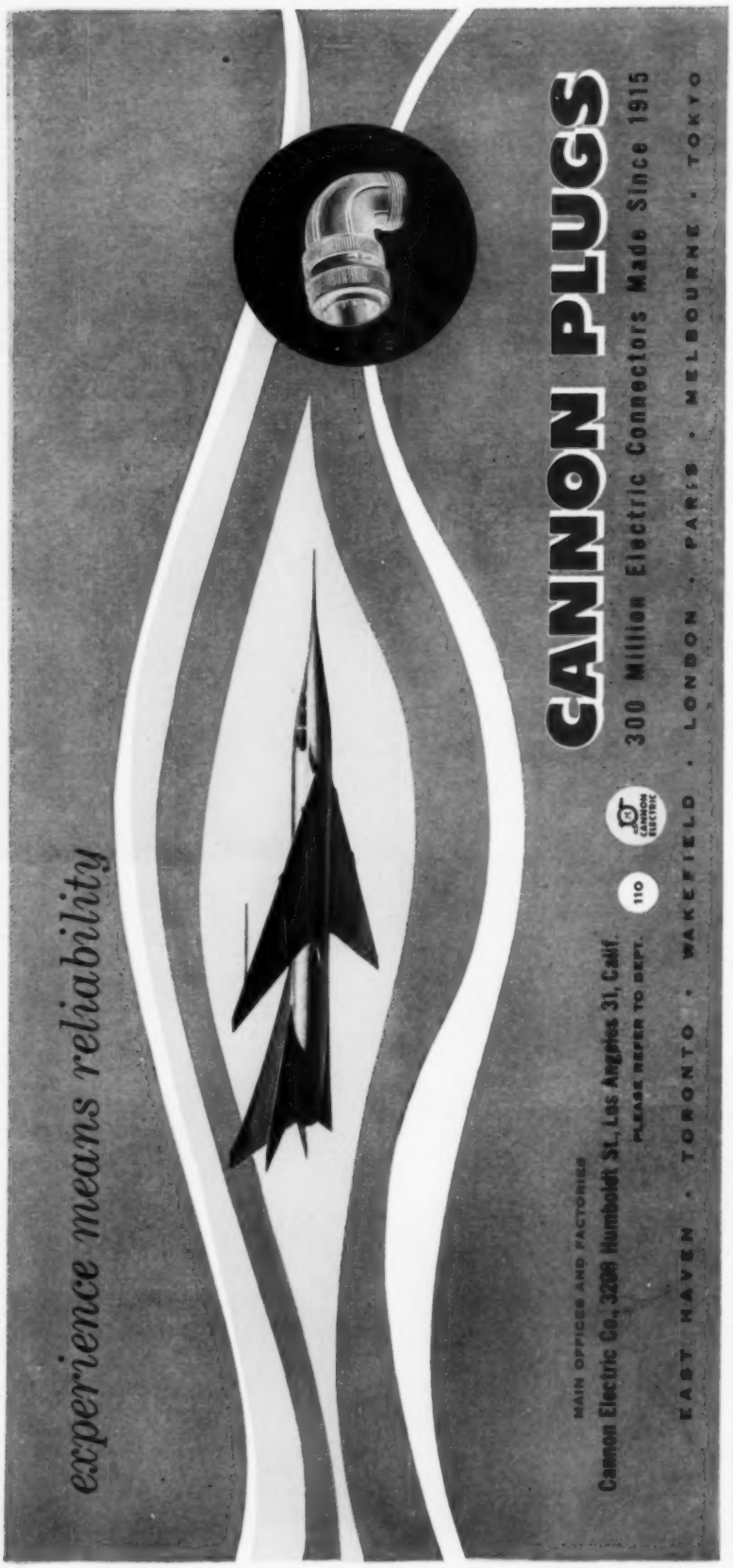
...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!

Lands or takes off in less than 10 times its own length. The Fairchild C-123 operates on any terrain with only 600 feet of field space.



Fairchild J44 turbojet engines give added power thrust to the C-123, providing an extra margin of safety for any emergency condition.

Loading ramp is built in. Up to 19,000 pounds of bulk cargo can be driven right into the fuselage, eliminating ground handling equipment.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Phillips 66
PRESENTS

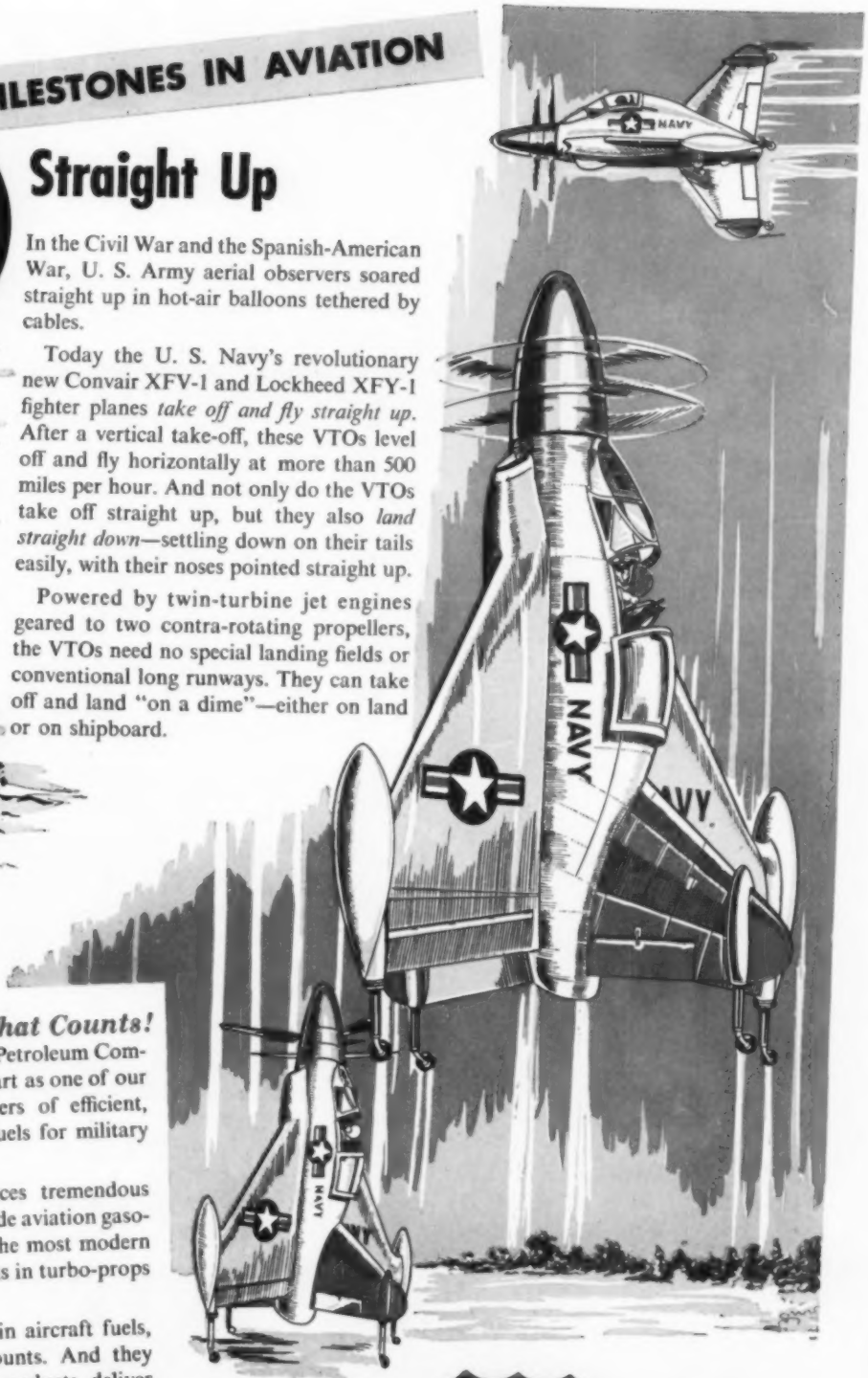
MILESTONES IN AVIATION

Straight Up

In the Civil War and the Spanish-American War, U. S. Army aerial observers soared straight up in hot-air balloons tethered by cables.

Today the U. S. Navy's revolutionary new Convair XFV-1 and Lockheed XFY-1 fighter planes *take off and fly straight up.* After a vertical take-off, these VTOs level off and fly horizontally at more than 500 miles per hour. And not only do the VTOs take off straight up, but they also *land straight down*—settling down on their tails easily, with their noses pointed straight up.

Powered by twin-turbine jet engines geared to two contra-rotating propellers, the VTOs need no special landing fields or conventional long runways. They can take off and land "on a dime"—either on land or on shipboard.



It's Performance that Counts!

For many years, Phillips Petroleum Company has performed its part as one of our country's leading suppliers of efficient, power-packed aviation fuels for military and commercial use.

Today Phillips produces tremendous quantities of 115/145 grade aviation gasoline, and also furnishes the most modern fuels for the latest designs in turbo-props and jets.

Operators know that in aircraft fuels, it's *performance* that counts. And they know that Phillips *66* products deliver *outstanding* performance!

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Long experience in designing fasteners and allied devices for leading aircraft manufacturers enables Monadnock to bring a wealth of specialized skill to bear on *your* particular fastening problems.

Large-scale production facilities for the fabrication and assembly of metal and plastic components ensure prompt delivery of volume orders.

WEDJIT — Seat and cargo tie-down fastener
AIRLOC STUD with nylon sealing ring fits standard Airloc
SOL-A-NUT Heat resistant stainless steel nut

MONADNOCK MILLS
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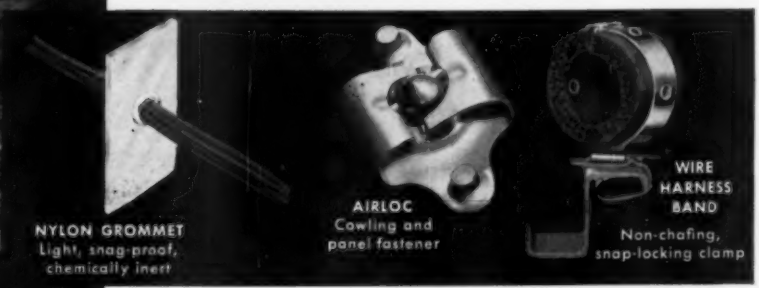
NYLON GROMMET Light, snag-proof, chemically inert
AIRLOC Cowling and panel fastener
WIRE HARNESS BAND Non-chafing, snap-locking clamp

Subsidiary of **UNITED-CARR FASTENER CORP.**

the NEW

MIDWESTERN MODEL 591 RECORDING OSCILLOGRAPH

for laboratory or flight test recording

See this oscillograph and many other of MIDWESTERN's test instruments and servo components in Room A at the New York IRE Show, March 19-22.

A few of its many features are—

12 inch width records • Recording speeds from .082 to 129.9 inches per second • Plug-in power supply units for immediate adaptation to 28 volts dc or 115 volts 60 or 400 cps power sources • Plug-in timing units which provide timing lines of .001 and/or .01, .01 and/or .10, or .10 and/or 1.0 second intervals • Precise timing synchronization between two or more units • Complete remote control facilities • Ability to operate under extreme temperatures and accelerations.

products

- Oscillographs (LABORATORY AND FLIGHT TEST)
- Magnetic Structures
- Galvanometers
- Amplifiers
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- Hydraulic Servovalves
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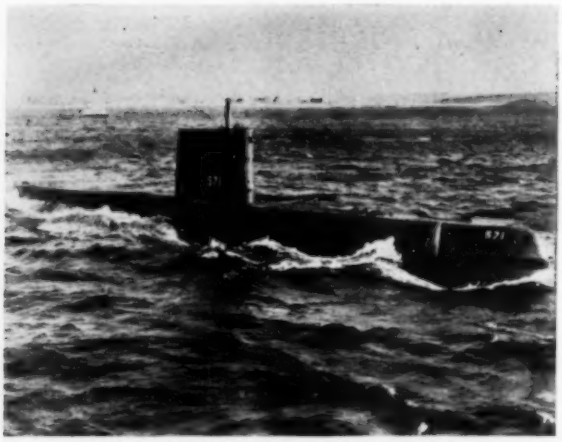
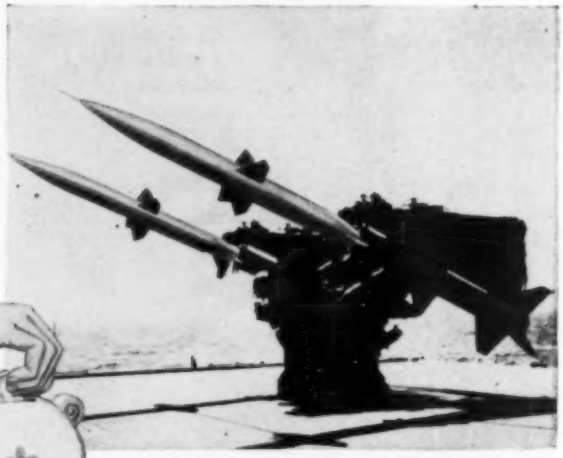


"Nautilus" Atomic Powered Submarine

Boeing B-52 "Stratofortress"

Convair F-102A Interceptor



Convair "Terrier" Surface-to-Air Missiles

Saving Defense Dollars with "American" welded components

Let Amweld's Industrial Products Division study your problem in circular welded components. Better yet, send us your blueprints and then your production can be "well on its way with Amweld."

The taxpaying public usually pictures Uncle Sam as being a loose man with a dollar, busily throwing our cash away with both hands. American industry, serving the defense program, will tell you nothing can be farther from the truth. On the contrary, the Government is running for top honors for sharp-pencil buying.

Typical of the Government's conservation program is the wide acceptance of rolled and flash welded rings as the most economical way to produce circular weldments for jet aircraft engines, guided missile parts and many other products of our military defense program.

"Value Analysis" is fast becoming a part of American industry's buying procedure. For further information on ring applications write to:

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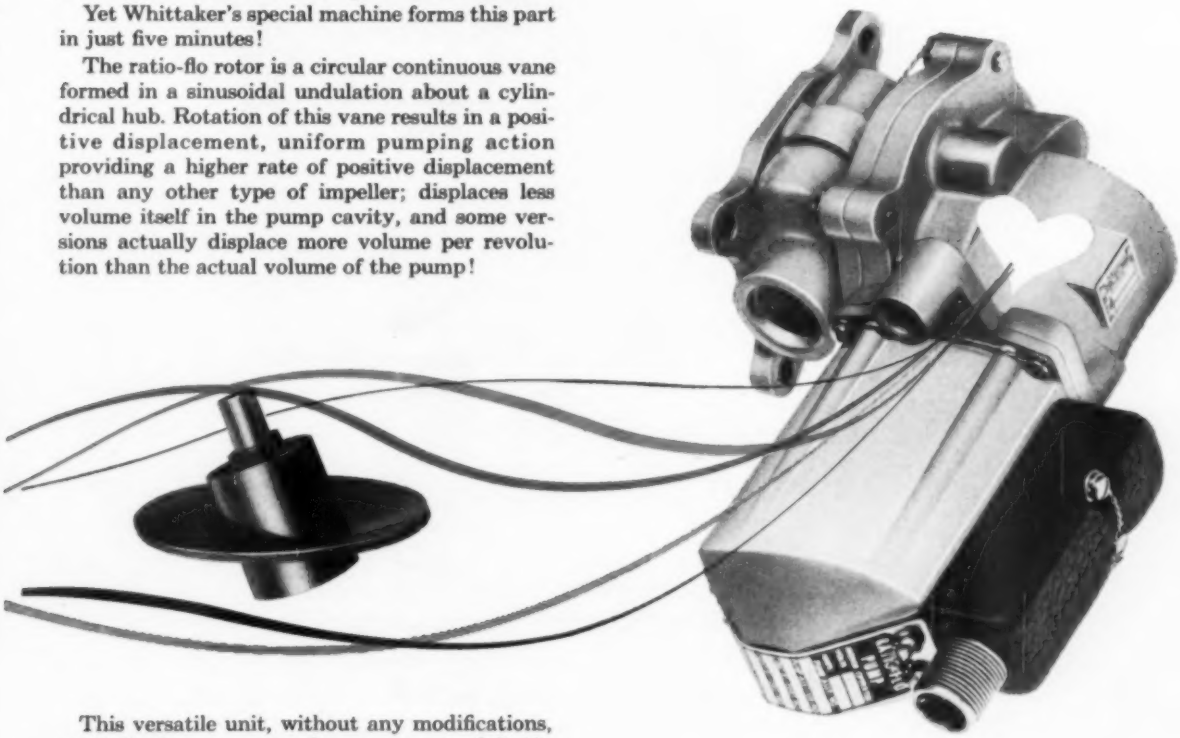
Why Whittaker Ratio-Flo Pump has a Five-to-One Advantage

The answer is the rotor—heart of the Whittaker Ratio-flo unit. Entirely new in concept, it has convolutions almost too complicated to define.

Yet Whittaker's special machine forms this part in just five minutes!

The ratio-flo rotor is a circular continuous vane formed in a sinusoidal undulation about a cylindrical hub. Rotation of this vane results in a positive displacement, uniform pumping action providing a higher rate of positive displacement than any other type of impeller; displaces less volume itself in the pump cavity, and some versions actually displace more volume per revolution than the actual volume of the pump!



This versatile unit, without any modifications, could divide two or more flows... pump and divide two or more flows... join two or more flows... pump and join two or more flows.

Your Whittaker Field Engineer can give you detailed information about these new fuel pumps, air pumps, flow joiners and flow dividers using the ratio-flo principle. Why not get in touch with him today.

Greatest advantage of the Whittaker Ratio-Flo pump is efficiency – in all cases over 80% as against the average pump efficiency of 15%. It draws constant current regardless of pumping rate, and current requirement is only about 1/3 to 1/5 as much as with a centrifugal pump.

Whittaker

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Gentlemen:
Please send me further information on Ratio-Flo Pump.

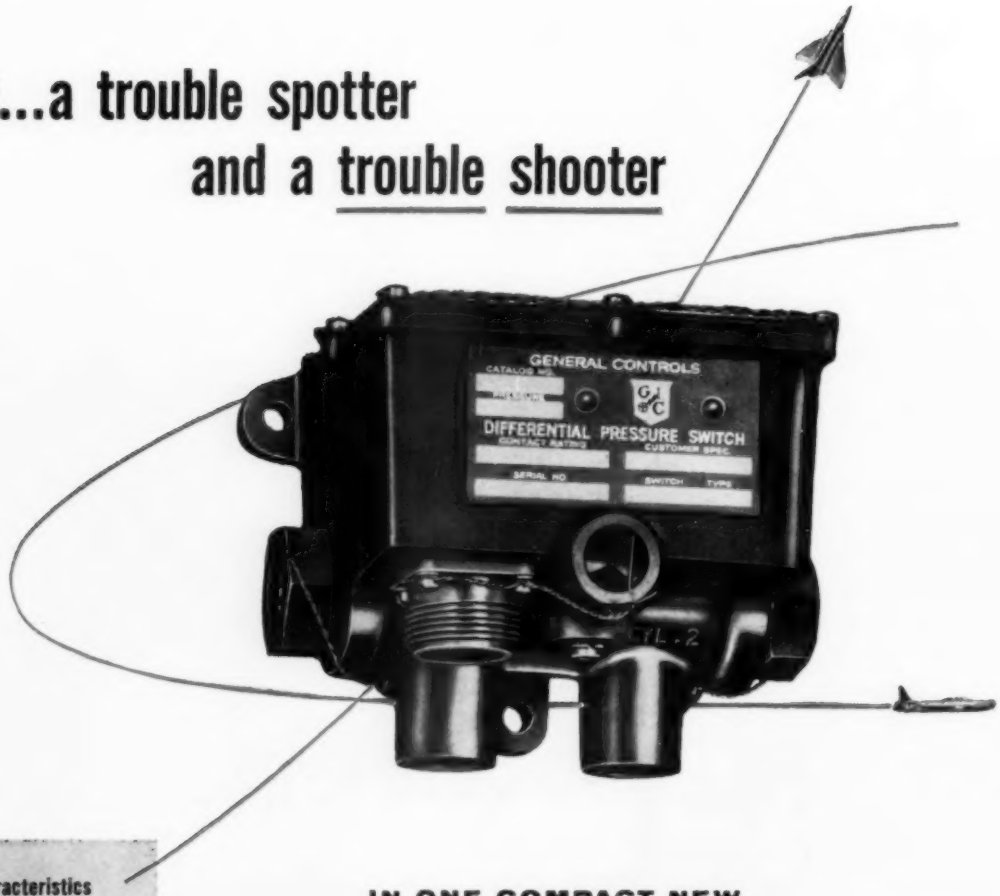
NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

now...a trouble spotter and a trouble shooter



AL-58N Characteristics

Operating Pressures—20 to 5000 psi
Inter flow between ports*—5 cu. in/maximum
Totally Enclosed and Explosion-Proof
Environment Resistance—Meets MIL-S-6743 and MIL-E-5272A
Switches—2 SPDT Standard, Variations Available
Weight—1.4 lbs. maximum
Size—3½" x 4½" approximately (*Seals can be used to prevent inter flow if desirable)

General Controls
hi-g
AL-58N
Dual-Sensing
Pressure Switch

IN ONE COMPACT NEW DUAL-SENSING PRESSURE SWITCH

The conventional pressure switch can only indicate when one pressure exceeds another by a certain amount. General Controls' new dual-sensing, balanced differential pressure switch goes far beyond that. It can watchdog two systems at once—completely. It is adjusted at "neutral" for the normal condition between two systems operating at the same or different pressures. Then, if unbalance occurs on either line—*it can detect it, determine the direction of the deviation (up or down), and actuate a corrective feedback action!* The AL-58N dual-sensing switch will also actuate warning lights in aircraft equipped with two pump hydraulic systems. Get General Controls' pressure switches into your plans for the future *now*. For information on the complete line, write for Catalog 53A.

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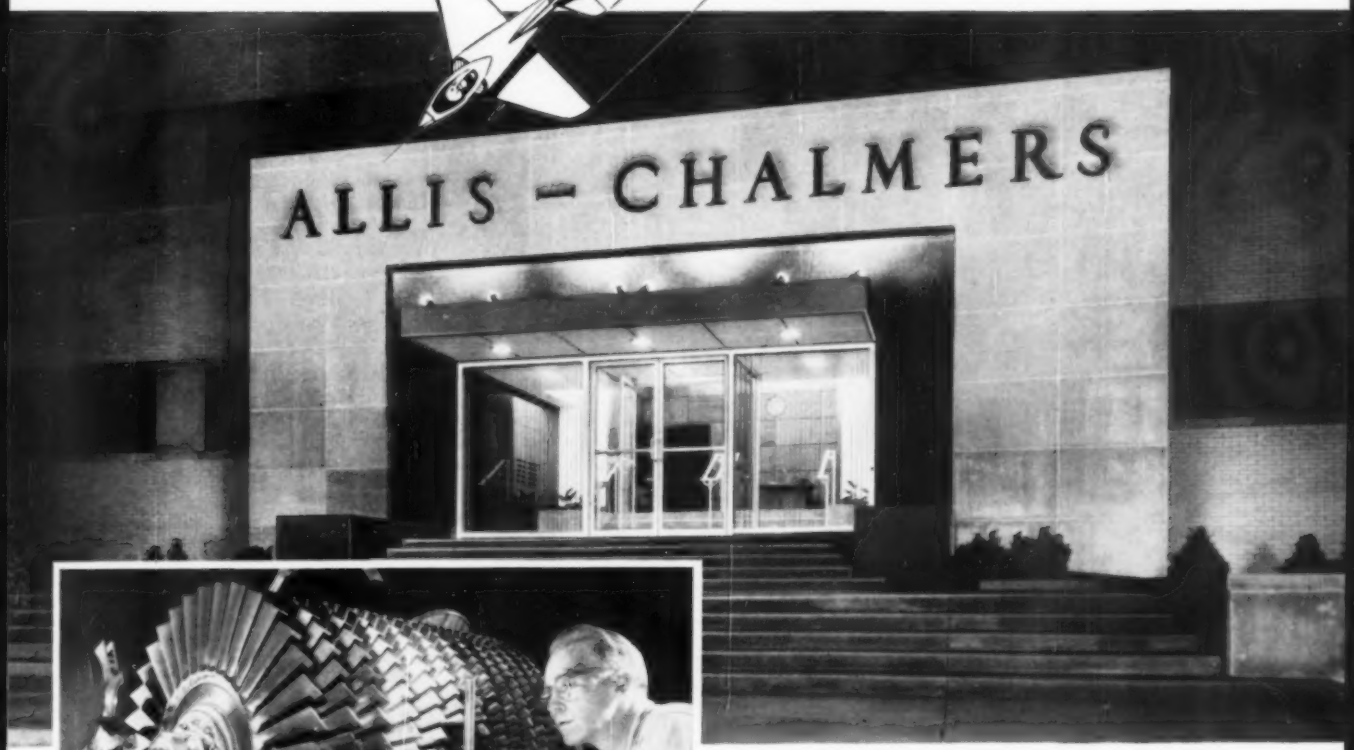

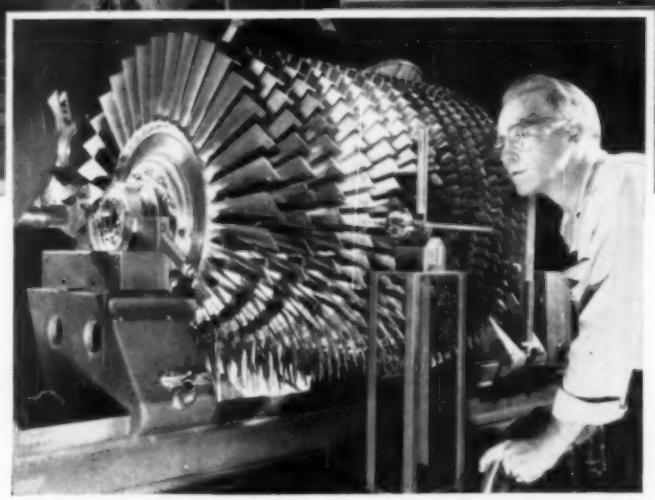

Axial-flow compressors built by A-C for Curtiss-Wright J65 turbojet engine require highest standards of precision workmanship.

Here—at Terre Haute—is a plant built and equipped for aircraft engine work. Allis-Chalmers not only handles precision machining and fabrication but also welding, plating and heat-treating operations.

If you have an assembly requiring quality craftsmanship, contact Allis-Chalmers, Terre Haute, Indiana.

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A-C ALLIS-CHALMERS

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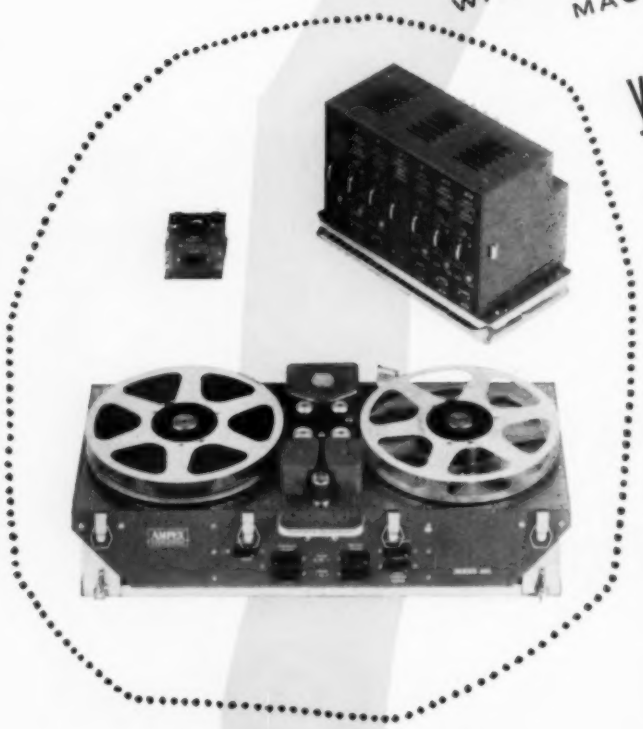
WITH THE AMPEX 800 AIRBORNE MAGNETIC TAPE RECORDER

you help yourself get the key facts faster



The Ampex 800 that you install in your aircraft is a vital link in a new data speed-up program. It records data on magnetic tape in a form most readily used by automatic data reduction systems. These are now being installed at government test facilities and at certain major aircraft manufacturers. Their objective is to get digested flight test data back to the engineer sooner.

The Ampex 800 has all the practical requirements for airborne recording in the most advanced military aircraft. It can record hundreds of simultaneous data channels (multiplexed onto 7 or 14 tape tracks). By interchangeable amplifiers it can encompass practically any conceivable combination of data. And the Ampex 800 is light in weight — low in bulk — and designed to high altitude environmental requirements.

You have greatest assurance of data compatibility when you choose the Ampex 800. It performs to precise standards and furnishes data for reproduction on other Ampex Recorder-Reproducers. These are the most widely used magnetic tape equipment and their standards are now accepted everywhere.

Ampex Corporation is prepared to give information and assistance on the entire data acquisition and reduction system of which the Ampex 800 Airborne Recorder is a part. For descriptive literature on the recorder, write Dept. UU-2460

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Contributing to the ever-increasing use of ELECTRONICS in AIRCRAFT Instrumentation, LORAL is continuing the development and production of Airborne Equipment — new in concept, miniaturization and combined with high accuracy.

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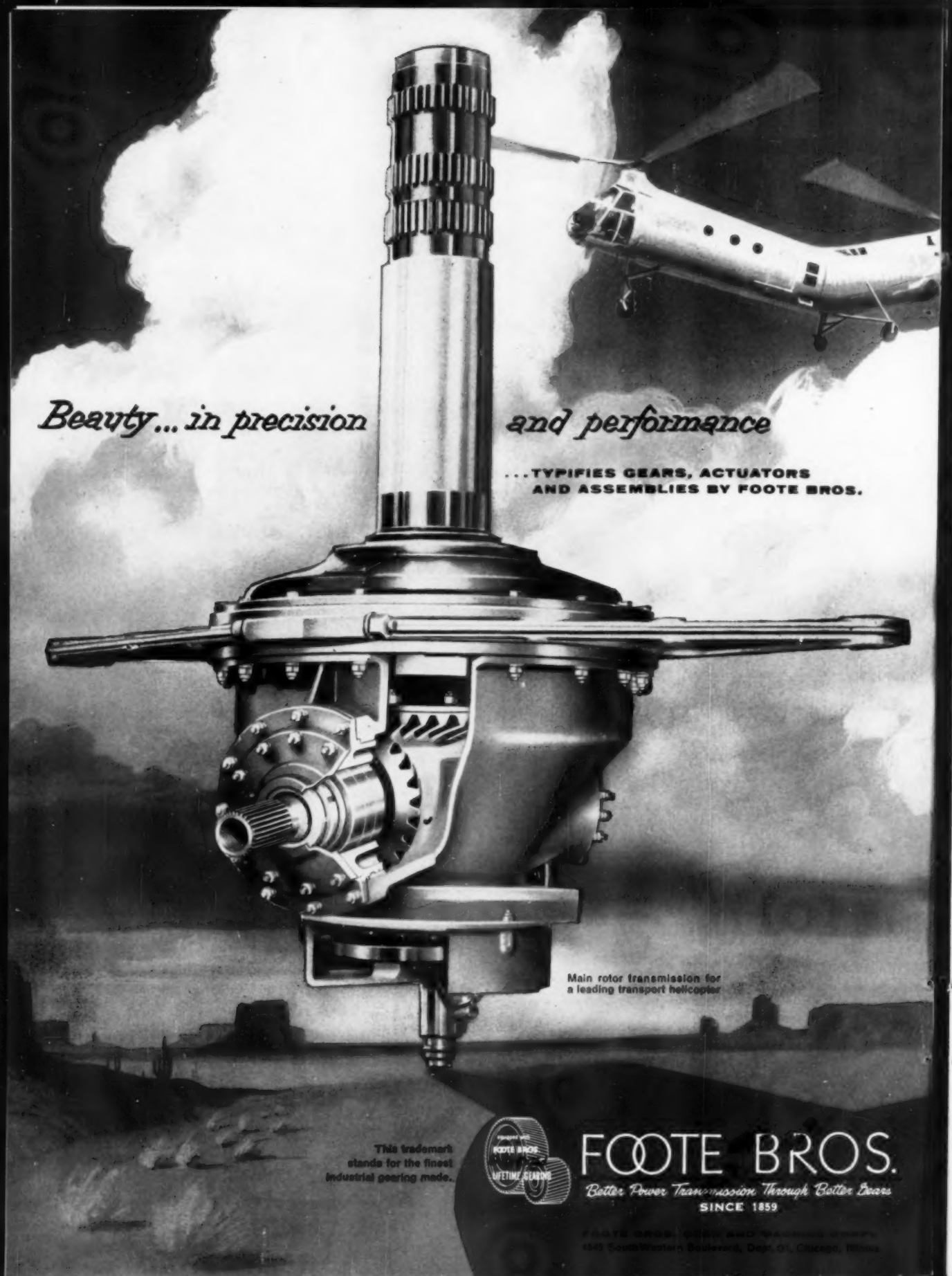
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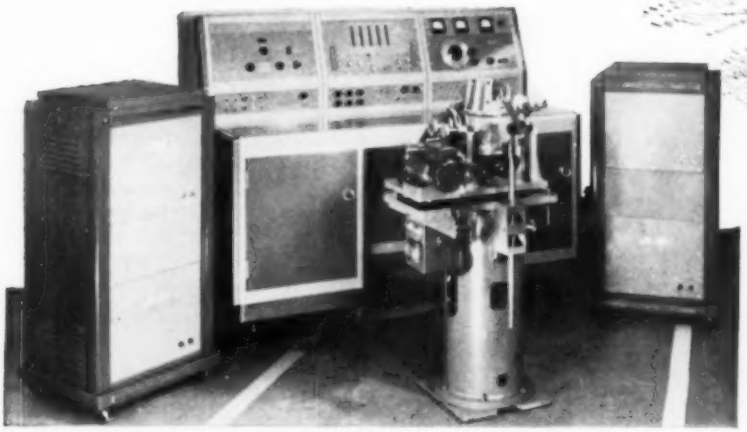
and performance
...TYPIFIES GEARS, ACTUATORS
AND ASSEMBLIES BY FOOTE BROS.
Main rotor transmission for
a leading transport helicopter
This trademark
stands for the finest
industrial gearing made.
FOOTE BROS.
Better Power Transmission Through Better Gears
SINCE 1859

ANOTHER FIRST BY Greenleaf

Dynamic Integrating Gyro Servo Table



Greenleaf Manufacturing Company, as a producer of Integrating Gyros, realized the need for a Dynamic Integrating Gyro Servo Test Table. This Test Table was designed and developed to facilitate the evaluation of Integrating Gyros, and Greenleaf now makes this valuable test unit available to industry.

The Gyro Servo Test Table can measure the following characteristics:

1. The drift rate of the gyro unit.
2. The current product angular velocity sensitivity ratio.
3. The characteristic time.
4. The angular velocity input voltage rate output sensitivity.
5. Minimum rate detectable.
6. High limit angular velocity deviation of performance.
7. Low limit angular velocity deviation.
8. Signal generator linearity.
9. Torque generator linearity.

Since a time interval meter is incorporated in the system, the following data can also be obtained:

10. Spin motor excitation frequency.
11. Spin motor excitation voltage.
12. Spin motor excitation current.
13. Signal generator excitation current.
14. Signal generator null output voltage.

In addition the following tests can be made:

15. Gyro damping gap temperature.
16. Accurate determination of the input axis.

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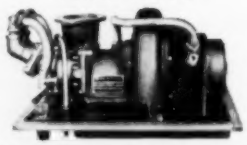
VICKERS "Instant Response"* HYDRAULIC MOTOR ... THE AIRCRAFT HANDY MAN

*Called "Instant Response" because it starts, stops or reverses almost instantaneously.

Vickers Constant Displacement Piston Type Hydraulic Motors are available in 24 sizes for 3000 psi.

Here Are a Few of the Jobs It Is Doing:

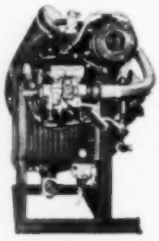
AERIAL REFUELING PUMP DRIVE



Fuel Transfer Pump built by Nash Engineering Co. for Boeing KC-97 Tanker. Powered by Vickers "Instant Response"* Hydraulic Motor.

CABIN SUPERCHARGING

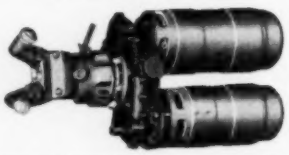
Douglas DC-7 Cabin Supercharger is driven by Vickers "Instant response"* Hydraulic Motor.



HORIZONTAL STABILIZER ACTUATOR

Built for Grumman F9F6 by Cleveland Pneumatic Tool Co. Powered by Vickers "Instant Response"* Hydraulic Motor.

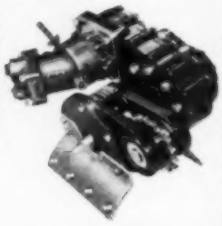
ALTERNATOR GENERATOR DRIVE



Alternator Generator Drive for Convair T-29 uses Vickers "Instant Response"* Hydraulic Motor.

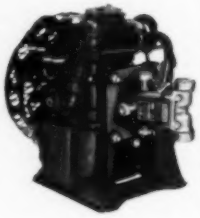
TELESCOPING BOOM ACTUATOR

Built by Jack & Heintz to extend and retract boom for in-flight refueling. Driven by a Vickers "Instant Response"* Hydraulic Motor.



AIR COMPRESSOR DRIVE

Built by Walter Kidde & Company, Inc. and driven by Vickers "Instant Response"* Hydraulic Motor.



What Can It Do for You?

These light-weight, compact, highly efficient hydraulic motors provide high power in a very small package. Their overall efficiency exceeds 92% . . . their volumetric efficiency exceeds 96%.

Operating characteristics are remarkable. These motors will stop from maximum speed in from .116 to .167 of a revolution . . . will accelerate from standstill to maximum speed in from .00019 to .0051 sec (depending on size). They can be stalled indefinitely without damage.

Vickers Hydraulic Motors have many uses on aircraft . . . just a few of them are shown above. Wherever you need high torque, high efficiency and high horsepower-weight ratio . . . or where instantaneous and positive control are required, these motors are your best choice. Write for Bulletin A-5205.

7044

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INCORPORATED
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Arlington, Texas, P.O. Box 213
Detroit 32, Michigan, 1462 Oakman Blvd.
Additional Service Facilities at:
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TELEPHONE: TOwnsend 8-5100 • TELETYPE: "TWX" DE89
TELEGRAMS: Vickers WUX Detroit • CABLE: Videt Detroit
OVERSEAS REPRESENTATIVE: Sperry Gyroscope Co., Ltd., Great West Road, Brentford, Middx., England.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

RELIABILITY

Dependable performance is a quarter-century tradition at Motorola—the world's largest exclusive manufacturer of electronic equipment. Under subcontract to Convair, Motorola *engineered for reliability,* and is now producing the guidance equipment for the Navy's new all-weather anti-aircraft missile, the "Terrier".

Positions open to qualified Engineers and Physicists

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COMMUNICATIONS & ELECTRONICS DIVISION
National Defense Department

2710 N. CLYBOURN AVE. • CHICAGO, ILL. • Laboratories: Phoenix, Arizona and Riverside, California

Bob
Fuik

What's behind the Broken Records?

They're coming so fast now they hardly make news. Records are made for speed, height, capacity – then smashed in short time by another newer, bigger commercial airliner. Back of these broken records is *brute power* – developed by ever greater, better engines . . . engines that *must* be protected against damaging heat and friction. Sinclair is proud of the part its Aircraft Oil plays in protecting these engines. *Today, more than 45% of the oil used by major scheduled airlines in the U. S. is supplied by Sinclair* . . . Proof positive of dependability.

SINCLAIR AIRCRAFT OILS

Sinclair Refining Company, Aviation Sales, 600 Fifth Avenue, New York 20, N. Y.

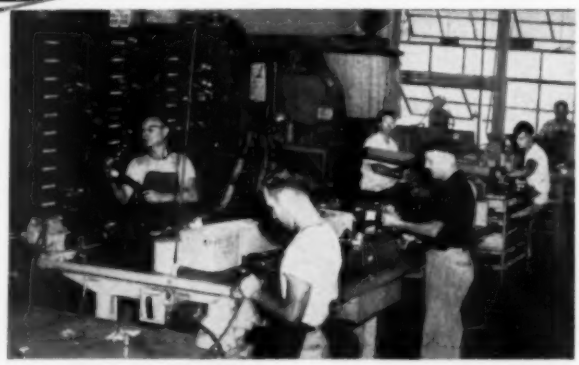
Aeroquip Hose and Reusable Fittings Cut Maintenance Costs for Eastern Air Lines

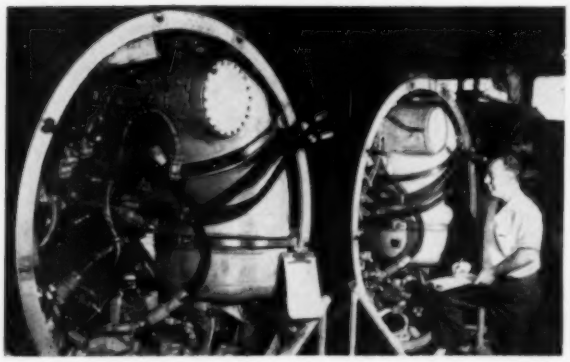
The periodic overhaul and inspection of each Eastern airliner includes removal and testing of every hose line. Aeroquip reusable fittings cut Eastern's replacement hose line costs, because the fittings can be used again and again. This Aeroquip advantage simplifies maintenance of military, corporate and private as well as commercial aircraft.

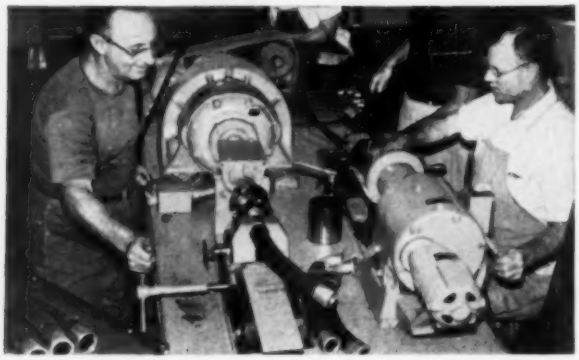
Right—In Eastern's Miami maintenance base, used hose lines are taken apart to salvage Aeroquip reusable fittings, which last indefinitely.

Lower Right—New hose lines, with both straight and elbow fittings, are assembled quickly by Eastern mechanics.

Below—Engine build-up foreman makes a final check of rebuilt engines. Every component has been rebuilt or replaced. Clamps on the oil tanks are made by Marman, an Aeroquip subsidiary.







Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

The only Rod End Series designed with THREE-WAY BALANCE

MEMO
Designers —
When you examine the Fafnir Rod End Series for Supersonic Aircraft Control Systems, be sure to notice the precise balance between bearing capacity, shank strength, and bolt strength. You'll find 1) no useless bearing capacity, 2) no unnecessary strength, 3) no excess weight in this rod end series.
LAH

AN OUTSTANDING EXAMPLE OF TEAMWORK

The manufacture of rod ends is nothing new to Fafnir. Nonetheless Fafnir bearing specialists sought the advice and counsel of engineers and designers in the airframe industry when they started to work on their latest series of rod ends. Selection of thread length and the design of keyways, criteria for establishing shank strength, along with other design problems, were subjects of cooperative study. The results — a self-aligning, balanced-design series of rod ends that meets the needs of supersonic aircraft control systems precisely. The ball type is designed for low-torque, sensitive, manually-operated control systems. The roller type is designed for use in heavily-loaded, power-operated control systems.

In addition to balanced-design, this rod end series offers many other features, including . . . inner rings of SAE 52100 steel, through-hardened; outer rings, with carburized races and integral shanks, made of highest grade alloy steel; shanks designed to withstand column action under compression with angularity as high as 9°. Complete details plus dimensions and load-life ratings are available in bulletin 446. Send for a copy. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
AIRCRAFT BEARINGS

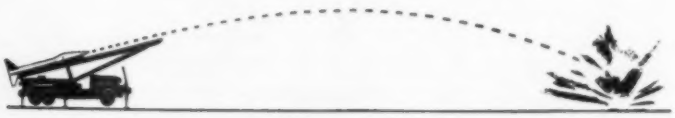
FIRST at the turning points in aircraft design

New missile marches with the infantry

Modern foot soldiers do more riding than walking. Trucks, tanks and parachutes give the infantry high-speed mobility that calls for equally mobile support weapons.

One such weapon is Honest John. Developed by Douglas in co-operation with Army Ordnance, this new missile is a free-flight rocket without complicated guidance system. It moves quickly into position on a special truck that serves both as transport and launcher. Highly accurate, Honest John can handle either a nuclear warhead or a single explosive round of enormous power.

The U.S. Army's Douglas-Designed HONEST JOHN Artillery Rocket



Defense is everybody's business. Development of Honest John by Douglas is an example of industry's role in U.S. defense. But weapons need people to make them work. The Army needs young men and women who agree that "defense is *everybody's* business."

Depend on *DOUGLAS* **First in Aviation**

"Know-How"

the most important ingredient for *Precision*

When it comes to aircraft hydraulic and pneumatic control equipment; heater, anti-icing and fuel system equipment; engine accessories and line supports... *"know-how"* and *precision* are our two greatest virtues.

Precision flying of modern aircraft requires skilled hands and hundreds of hours of experience. Today's military and commercial airplane and rotary wing aircraft require *precision* components and accessories like ADEL's. Many years of specialized experience, matchless skill and consistent emphasis on *precision*-production provide the aircraft industry with equipment that conforms to or exceeds all applicable specifications.

We can either build them to your specifications or design them to meet your requirements.

BE *Adel-wise*... SPECIFY ADEL

Hydraulics, Pneumatics and Controls Engineers are urgently needed and offered exceptional opportunities

Write for descriptive Brochure containing detailed information on ADEL's line of Aircraft Equipment and facilities

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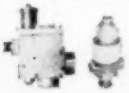
PRECISION PRODUCTS
A DIVISION OF GENERAL METALS CORPORATION

BURBANK, CALIFORNIA · HUNTINGTON, WEST VIRGINIA
CANADA: RAILWAY & POWER ENGINEERING CORPORATION, LIMITED

ADEL designs and manufactures aircraft accessories in the following major categories:

HYDRAULIC & PNEUMATIC CONTROL EQUIPMENT 

ANTI-ICING, HEATER & FUEL SYSTEM EQUIPMENT

ENGINE ACCESSORIES

LINE SUPPORTS

Heat eats metal. That is one reason why AC engineers developed a

3-PRONG ELECTRODE

As you can see in the illustration, each tip of the three-prong electrode flares out into a broad base. This helps conduct heat away from the electrode rapidly. Results? Less erosion . . . better performance over a longer period of time . . . and longer plug life!

In addition to better heat dissipation, AC has found this three-prong design offers other great advantages—better scavenging action to reduce fouling, and easier, more effective cleaning action when plugs are being reconditioned. That is why a three-prong electrode was developed in 1940 by AC engineers for use in aircraft spark plugs, and why it has been used in many applications for the past fifteen years.

Insist on this AC development in the plugs you buy, and the planes you fly. Insist on AC Aircraft Spark Plugs.

AC SPARK PLUG
THE ELECTRONICS
DIVISION
OF
GENERAL MOTORS
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GM GENERAL MOTORS

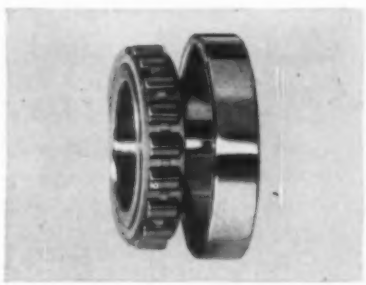
AC AIRCRAFT SPARK PLUGS

DISTRIBUTED BY: **Airwork Corporation:** Millville, New Jersey; Miami Springs, Florida; Newark, New Jersey; Atlanta, Georgia; Arlington, Virginia. **Pacific Airmotive Corporation:** Burbank, California; Seattle, Washington; Oakland, California; Kansas City, Kansas; Denver, Colorado; Linden, New Jersey. **Southwest Airmotive Company:** Dallas, Texas. **Van Dusen Aircraft Supplies, Inc.:** Minneapolis, Minnesota; Teterboro, New Jersey; East Boston, Massachusetts; Alexandria, Virginia. **Standard Aero Engine Ltd.:** Winnipeg, Manitoba; Vancouver, B.C.; Edmonton, Alberta; Toronto, Ontario; Montreal, Quebec.

Margin for Error . . . *None!*

You swing into your final approach. At precisely the right instant the Landing Signal Officer flags you to cut your power—and you're aboard! ☆ Such skill and precision is indicative of that which is required today in *every* phase of the aircraft industry. The bearings in modern jet turbines, for instance, must be held to accurate tolerances measured in millionths of an inch. That's why the leading jet turbine manufacturers specify Bower aircraft bearings first. Their exceptional high quality and unerring precision allow Bower bearings to stand unbelievable turbine speeds and temperatures—that match the supersonic speeds of today's jet aircraft—*with a minimum of lubrication.* ☆ Whatever *you* produce, if it uses bearings, specify Bower! Choose from a complete line of tapered, straight and journal roller bearings for every field of transportation and industry.

BOWER ROLLER BEARING DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 14, MICHIGAN



IDEALLY SUITED TO HIGH-SPEED OPERATION

Built to hold their precision indefinitely, these aircraft bearings are recommended wherever superior quality and high-speed operation are required. For some applications, a special alloy steel—developed jointly by Bower and several aircraft companies—is used.

BOWER ROLLER BEARINGS

PLANE FAX

Your Best Week-end Flight Plan for March

Plan to visit Nevada's Valley of Fire any week-end this month, while the desert flowers are in bloom. Land at nearby Boulder City Airport for boat and motor transportation and for quality Standard Aviation products.

Listening for uranium in Monument Valley

Prospecting from the air! Skirting cliffs, hopping over boulders, and dodging pillars of rock, "Ace" Hibbard spent days flying through Utah's weird, desolate Monument Valley carrying a modern prospector and his radiation counter. Whenever they heard the hum that indicated uranium, his job was to drop closer to the desert floor and fly tight circles until the hot spot was noted on their maps.

A pilot who is also a certified A & E, Mr. Hibbard says, "Low flying over the desert calls for plenty of available extra power, and I make sure of it with Chevron Aviation Gasoline 80/87. I do a lot of mountain flying near my home port at Auburn, California, and Chevron 80/87 always gives me the extra power I need.

"I keep all my engines running clean and free, too, with RPM Aviation Oil. I've never seen another oil clean out sludge so well, and hold down head deposits at the same time. I made a top overhaul at 700 hours, and the pistons were so clean I could still read the stamped letters on their tops."

T. M'S "RPM," "CHEVRON," "PLANE FAX," REG. U.S. PAT. OFF.

TIP OF THE MONTH

It's a good idea to keep your windshield spotless and unscratched. This can be a big help in giving you better vision on night flights.

CHEVRON AVIATION GASOLINE

RPM AVIATION OIL

STANDARD OIL COMPANY OF CALIFORNIA

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A-MP'S

NEW UNIVERSAL PATCHCORD PROGRAMMING SYSTEMS

SYSTEMS are designed especially for programming required on

- Analog Computers
- Digital Computers
- Data Processing Equipment
- Test Equipment
- Automatic Control Equipment and similar devices

These units incorporate many new design features that assure reliable programming for the most critical applications. They are now available with 240, 816 and 1632 contacts.

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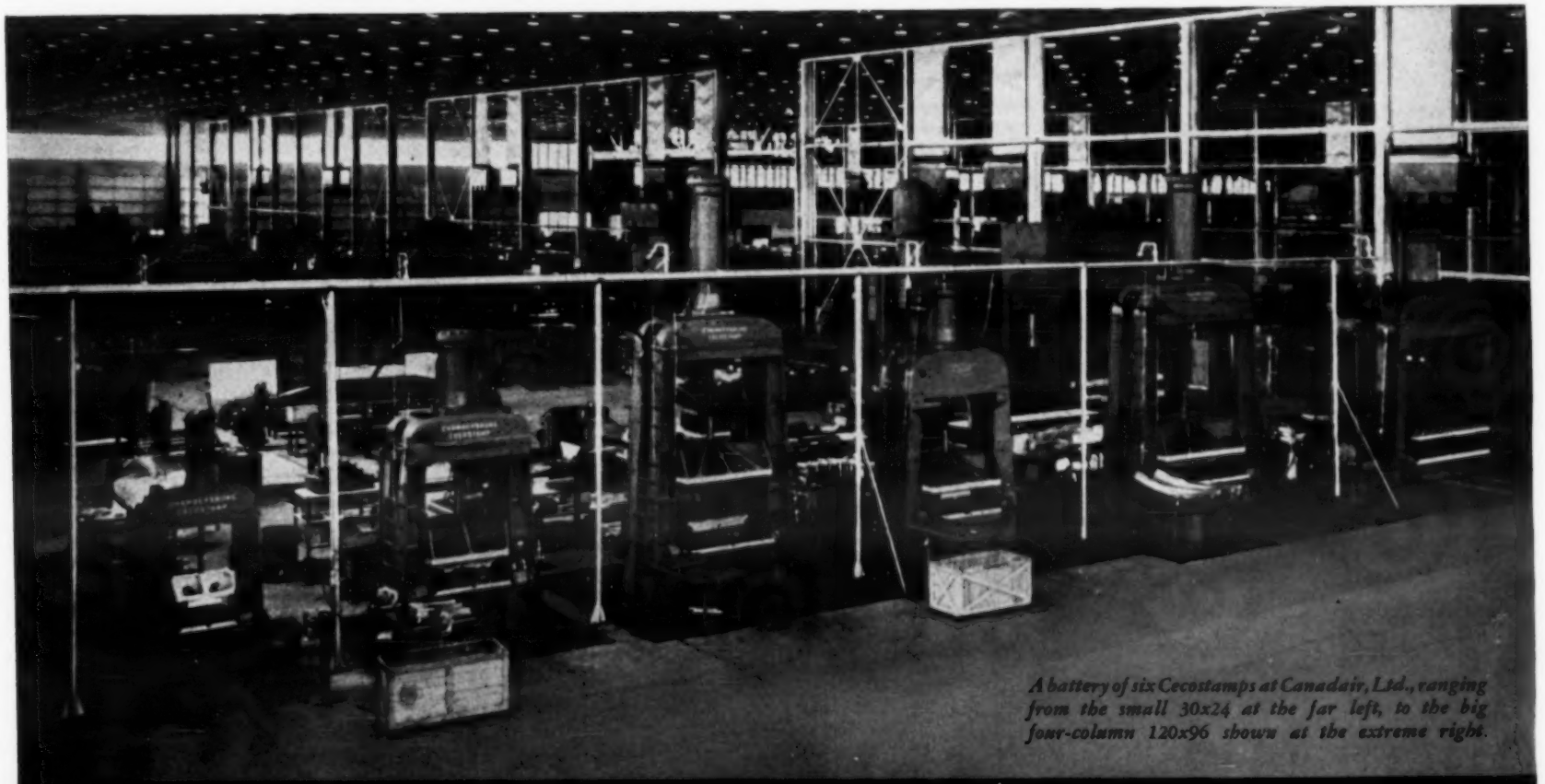

A battery of six Cecostamps at Canadair, Ltd., ranging from the small 30x24 at the far left, to the big four-column 120x96 shown at the extreme right.

CECOSTAMP

THE STANDARD IMPACT DROP STAMP OF THE AIRCRAFT INDUSTRY

Write for a copy of Bulletin 30-L-5

CHAMBERSBURG ENGINEERING COMPANY · CHAMBERSBURG, PENNA.

Keeping Pace with Air Progress!

Chatham Electronics

...offers advance design in

LIGHTWEIGHT AIRBORNE CONVERSION EQUIPMENT

At the I.R.E. Show!
474-476-478
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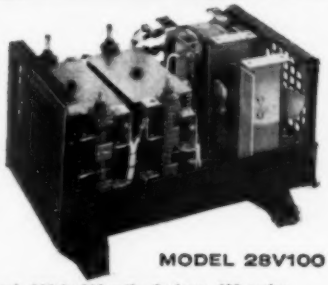


MODEL 28V100

Input—195 to 210 volts, 3 phase, 400 cycles
Output—28 volts DC, 100 amperes
Regulation—25 to 31 volts at 0 load to 100 amperes
Weight—under 17 lbs.

Chatham Type 28V100 is a major step forward in the design of airborne power supplies. Employing long life, lightweight CHATHAM kotron Selenium Rectifiers, this 100 ampere power supply provides substantial weight savings, greater reliability, improved electrical characteristics and reduced size. Featuring ruggedized construction throughout, Type 28V100 exceeds the requirements of MIL-P-7212 specifications. For complete information, call or write—

Aircraft Equipment Department of:

CHATHAM ELECTRONICS

Division of Gera Corporation — LIVINGSTON, N. J.

Designers and Manufacturers of Electronic Tubes and Equipment for Government and Industry

Important things are happening at Bendix-Utica

Bendix 2 IN 1

STARTER-GENERATOR

answers today's crying need for REDUCED SIZE AND WEIGHT • MORE GENERATOR CAPACITY • FASTER ENGINE STARTS

As they increase in power, *conventional* starters and generators also increase in size and weight. Yet, in modern jet aircraft, allowable space and weight for such accessories are already at a premium.

An efficient Bendix-Utica answer is the Type 30E13 starter-generator which *combines both functions in one compact, 86 lb. package.* The only 500-amp. starter-generator in production, the 30E13 provides fast, direct cranking of turbo-jet engines and supplies 30-volt DC power.

Already operational on some of America's latest jets, the 30E13 is capably answering the critical need for increased generator capacity and increased starting horsepower and acceleration to engine idle, together with lighter weight and less bulk.

The proved success of the 30E13 is another example of how Bendix-Utica's specialized facilities and know-how help aviation by constantly developing *better* products. For the latest on advanced turbine-driven, and other, accessories and components, write UTICA DIVISION, BENDIX AVIATION CORPORATION, UTICA, N. Y.

West Coast Office: 117 East Providencia Ave., Burbank, Calif.
Export Sales and Service:
Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

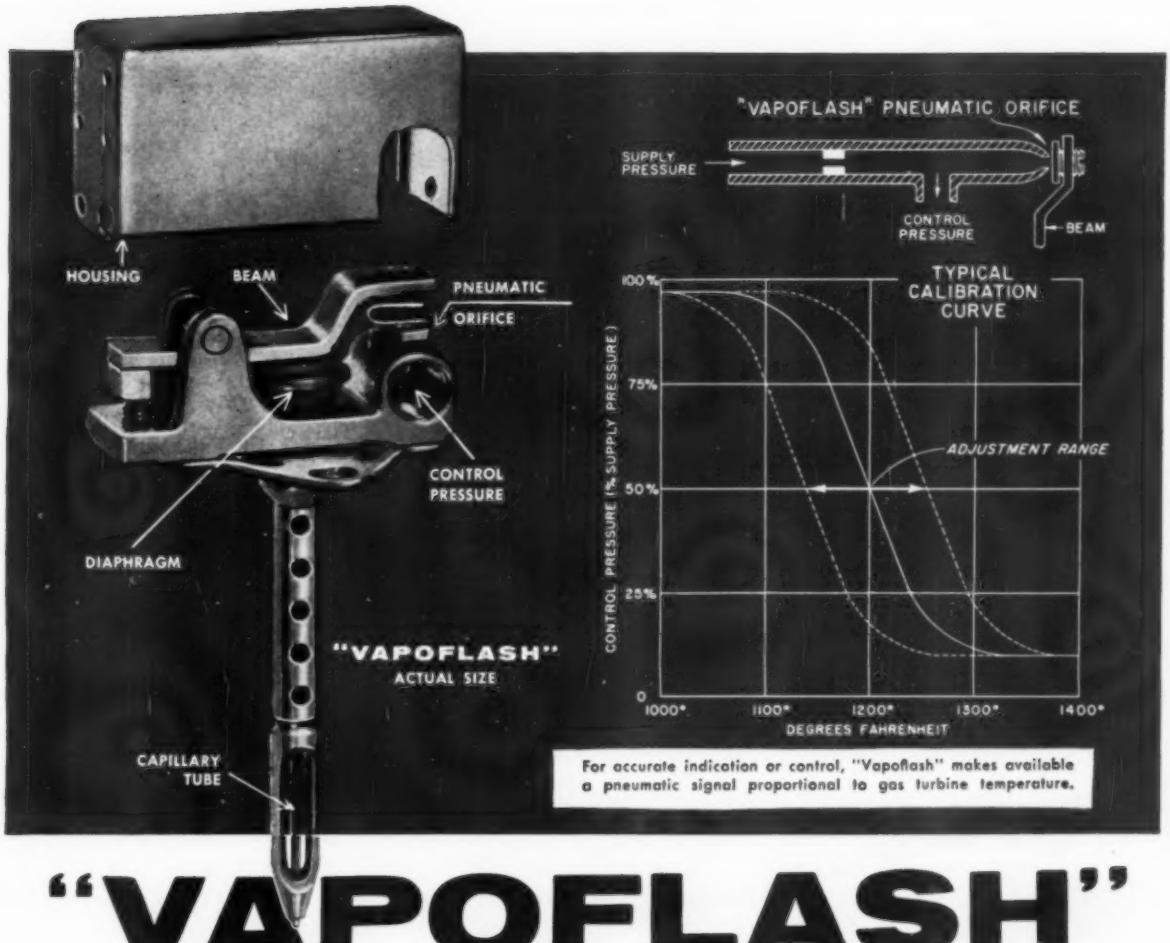
***OPPORTUNITIES EXIST** for qualified engineers on the products listed below.*

Specialists in turbine-driven and advanced aviation accessories and components

STARTERS • TURBINE PRODUCTS • PUMPS • DE-ICING SYSTEMS
AIRBORNE AIR CONDITIONING • ENGINE CONTROLS
SERVICE TEST EQUIPMENT AND TOOLS

Utica DIVISION

Bendix AVIATION CORPORATION



"VAPOFLASH"

. . . an entirely new development in gas turbine control components

"Vapoflash" — a unique new measuring probe — provides the advantage of high-gain, pneumatic output. The power level of the control signal is such that greatly simplified mechanisms can be applied to modulate main engine and afterburner fuel flow, and the exhaust nozzle area of turbojet engines.

The accurately calibrated "Vapoflash" probe exposes a mercury-filled capillary tube to the gas stream of the jet engine. As the gas temperature rises to the control set point, the pressure of the vaporized mercury in the element develops a signal which is measured by a metal diaphragm. As the diaphragm moves, it actuates a preloaded cantilever beam which operates a pneumatic orifice. Compressor discharge pressure serves as supply pressure: adequate power is conveniently available for control actuation. With several "Vapoflash" units connected in parallel for averaging, reliable measurement and control of gas turbine temperatures is simplified.

We are confident that our long experience in developing, manufacturing and testing jet engine control components can be of practical service to you. Our engineering department will welcome the opportunity to analyze your control requirements.

MANNING, MAXWELL & MOORE, INC.

AIRCRAFT PRODUCTS DIVISION • DANBURY, CONN. • STRATFORD, CONN. • INGLEWOOD, CALIF.

OUR AIRCRAFT PRODUCTS INCLUDE: TURBOJET ENGINE TEMPERATURE CONTROL AMPLIFIERS • ELECTRONIC AMPLIFIERS PRESSURE SWITCHES FOR ROCKETS, JET ENGINE AND AIRFRAME APPLICATIONS • PRESSURE GAUGES THERMOCOUPLES • HYDRAULIC VALVES • JET ENGINE AFTERBURNER CONTROL SYSTEMS.

...the *Bellairus*
for the executive who's going places!

Bell Aircraft Corporation's newest helicopter... the Model 47H BELLAIRUS... answers today's need for fast, dependable, ultra-safe transportation.

This is the only vehicle which can by-pass traffic-choked roads and highways on a *door-to-door* basis. Busy executives are saving 75 per cent of travel time by using the BELLAIRUS for quick trips from plant to plant, office to plant and office to airport.

The BELLAIRUS can fly anywhere, land anywhere... on a rooftop or a parking lot. It autorotates (safely descends without power) and incorporates all the famous Bell-engineered features which have been operationally proven by two million helicopter flight hours.

Equipped with floats, the BELLAIRUS makes a round trip from an office building to a field location to an off-shore installation without the necessity of changing vehicles.

Let us tell you why... a Bell helicopter can be an important asset to the *executive who's in a hurry to go places.*

FEATURES

- **Economical**
- **Amphibious**
- **Soundproofed cabin**
- **Extra baggage storage**
- **Custom interior**

BELL *Aircraft* CORPORATION

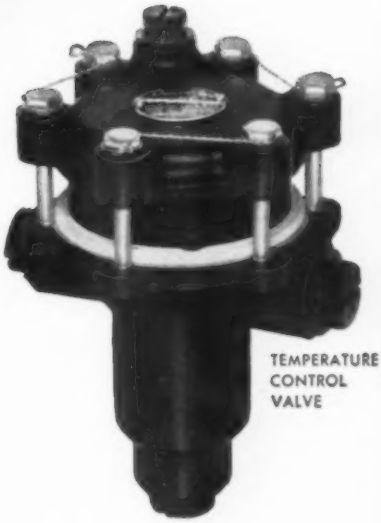
TEXAS DIVISION • P.O. BOX 482 • FT. WORTH, TEXAS

PNEUMATICS

TEMPERATURE SENSER

ABSOLUTE PRESSURE REGULATOR

GAGE PRESSURE REGULATOR



TEMPERATURE CONTROL VALVE

CHECK VALVE

by

Century Controls CORP.

ALLEN BOULEVARD, FARMINGDALE, L. I., N. Y., CH 9-5900

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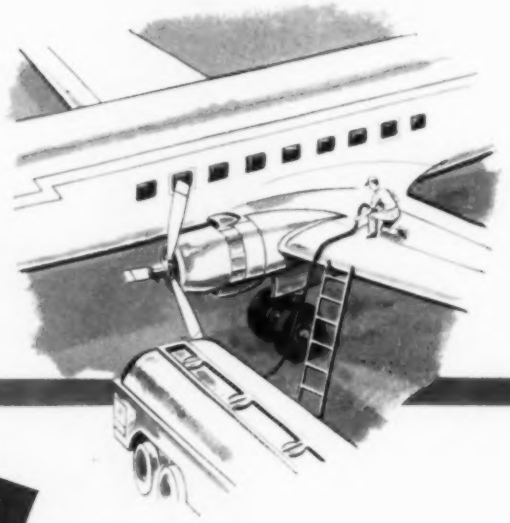
Today's aircraft depend on adequate controls to achieve speed and maneuverability. Century products provide efficient control through the utilization of inherent bleed-air power. Thus, modern jet planes are able to achieve greater speed and distance with safety, through Pneumatics . . . the dependable stock-in-trade of Century Controls Corporation.

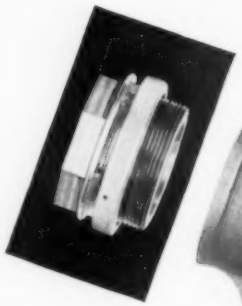
SEND FOR THIS INTERESTING BROCHURE
on Century's program, facilities, and products

No problem with **SHOCK** with this soft-closing refueling nozzle

Buckeye Model 9162 Hy-capacity valve is expressly designed to minimize shock. The valve offers flexibility unusual in such a nozzle: in addition to quick connections shown, standard threaded connectors can be supplied.



Four different tubes can be used with the *Quick Connect Outlet Adapter*



Strainer instantly accessible with the *Quick Connect Inlet Adapter*

Use same hose for over-wing and under-wing nozzles with the *Quick Connect 360° Swivel*

For complete details, write

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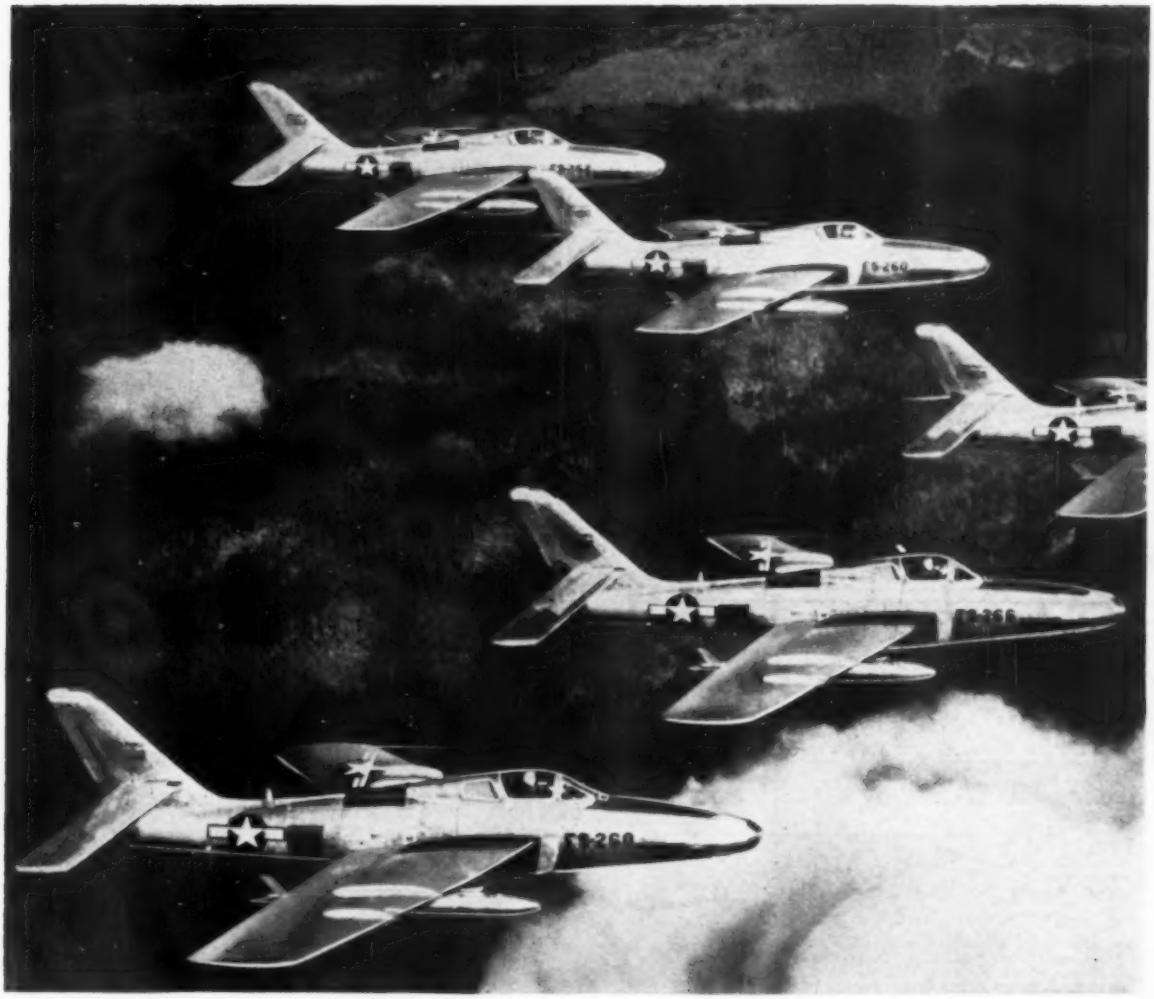
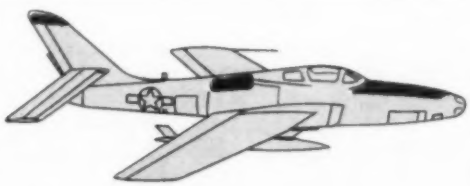
P. O. Box 883, Dayton 1, Ohio

Buckeye

VALVES AND FITTINGS FOR THE OIL AND AVIATION INDUSTRIES



Plastics in the air...



The Republic RF-84F *Thunderflash* photo-recon fighter, and its sister-ship the F-84F *Thunderstreak* fighter bomber are only two of the dozens of current production aircraft using BASSONS plastic parts.

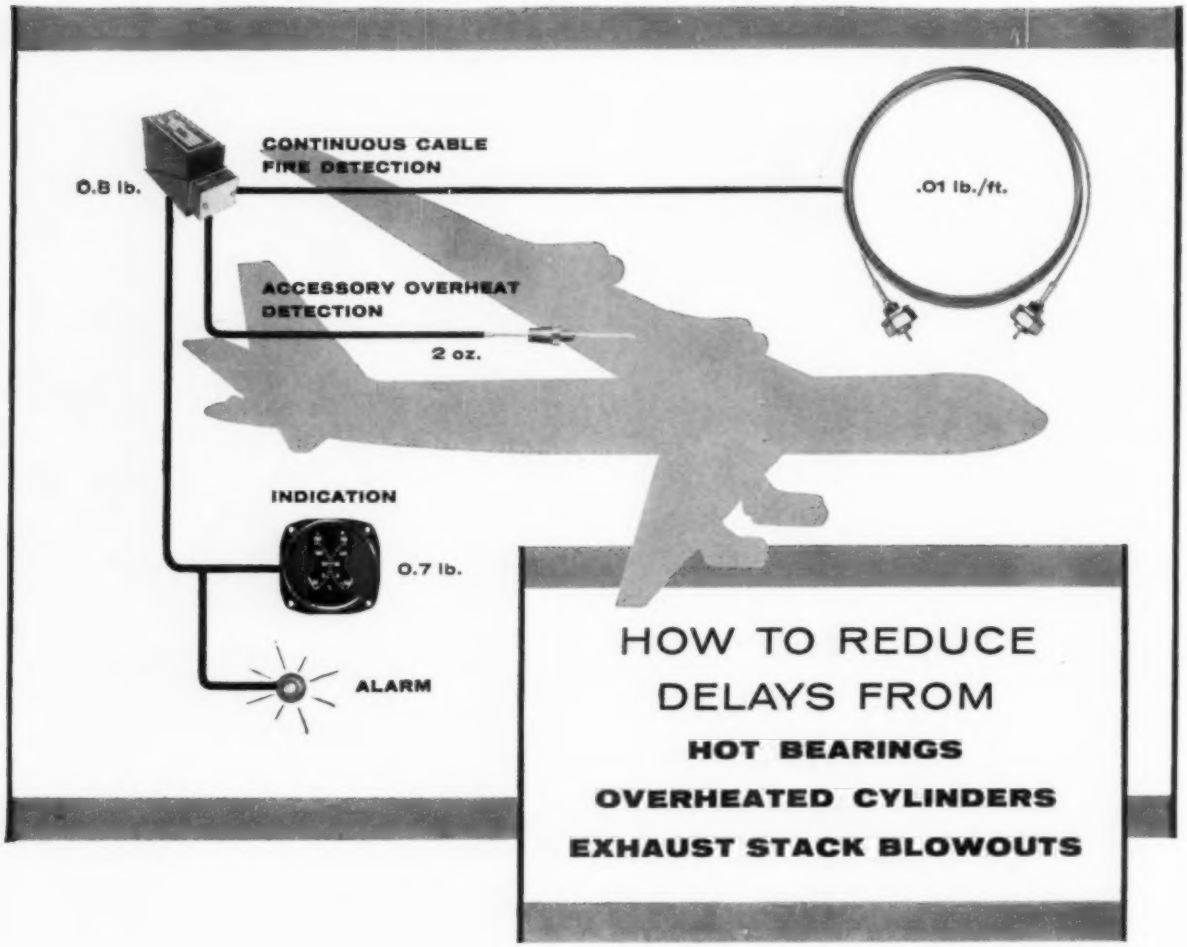
Bassons' specialized research, design, development and production teams keep constant pace with the ever-changing complexities in military and industrial requirements.

The current weapons system concept in defense planning demands the optimum in creative engineering and production efficiency. In a weapon system, performance is the outstanding consideration . . . In plastics, BASSONS is the outstanding supplier.

Let us design and develop your plastic components to provide efficient, low-cost answers to your performance problems . . . then, let us produce them to meet your specifications and delivery schedules, with the same efficiency and economy. Write TODAY for facilities brochure and complete information.

B I C

BASSONS INDUSTRIES CORP.
1432 West Farms Road, New York 60, New York
"From Idea To Product"



These and many other temperature control problems are being solved daily by Edison engineers. In the field of *fire detection*, Edison systems are in service in more than 10,000 aircraft . . . from the DC-3 to the giant Convair B-36. And in thousands of other airplanes Edison *overheat warning* systems are now guarding against bearing trouble in alternators, generators, superchargers and other vital equipment.

Usually within days we can deliver a prototype system tailor-made to solve your particular problem. Production changeovers can be made quickly since basic components are assembled to a printed circuit chassis. Non-electronic system makes installation fast and easy and can be done by any aircraft electrician. All wiring between components is standard insulated copper. The basic control system and standard sensing elements have been approved for military and commercial aircraft use.

Experienced engineers are located in our Dayton, Glendale, Ft. Worth and Chicago offices. For a practical approach to your problem, call us or write:

You can have –

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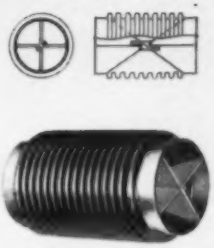
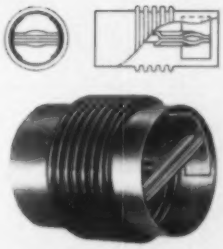
OF THERMAL LOADS IN AIRCRAFT PNEUMATIC DUCTING SYSTEMS



Center link type bellows tie-rod available in all diameters from 1" to 8".



Double link bar type bellows tie-rod available in all diameters from 1" to 8".

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To Control or Absorb Thermal Growth of stainless steel ducting by angular deflection, Arrowhead bellows tie-rod assemblies offer the optimum for low force deflections. Unlike braided bellows, these tie-rod assemblies are internally restrained. Due to this type of restraint, the actual deflection force required, in many cases, is 1/10th of the force required with braided bellows. Although there is a small pressure drop* with bellows tie-rod assemblies, they have special value in a tension system because they reduce the bending moments . . . reduce the column loadings and the reaction loads at the mounting flanges.

Single Pivot Type, shown above, anchors the ends of the bellows at a single point along the bellows center line.

Double Pivot Type, shown at right, employs two pivot points on the bellows center line to anchor the ends of the bellows. This type is capable of absorbing some lateral offset.

Arrowhead builds a complete line of stainless steel ducting components including pressure compensators, bellows, bellows tie-rods, braided bellows, and ducting assemblies.

**Example:* Pressure drop at a flow of 120 lbs. per minute is 25" of water (3" I.D. duct with bellows 2½" long and 4" overall unit length).

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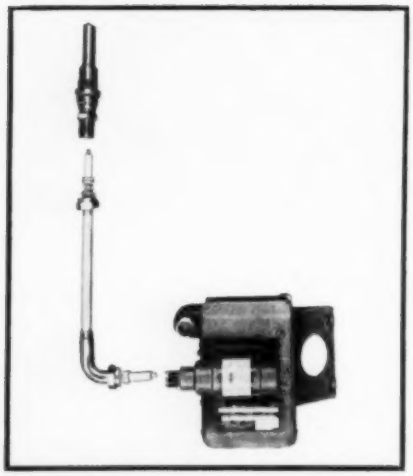

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These weather items prepared in consultation with the United States Weather Bureau

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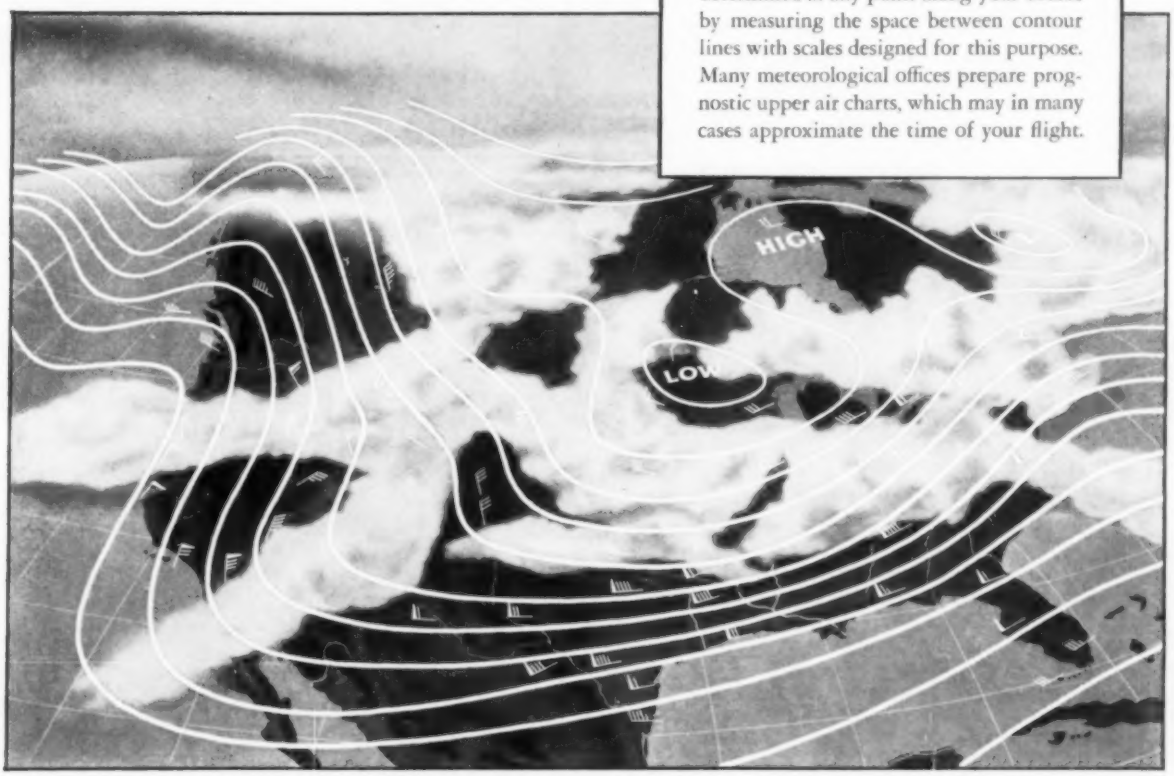
Upper air charts are useful in planning the least time track to your destination. These weather maps are drawn for certain standard altitudes: 5,000, 10,000 and 18,000 ft. approximately.

As on ordinary surface maps, the wind flows approximately parallel to the contour lines . . . counter-clockwise around lows and clockwise around highs in the northern hemisphere. Wind velocity can be determined at any point along your course by measuring the space between contour lines with scales designed for this purpose. Many meteorological offices prepare prognostic upper air charts, which may in many cases approximate the time of your flight.



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These new Cutler-Hammer One Hole Mounting Lever Lock Switches are available in constructions to prevent inadvertent operation from any lever position to any other lever position. Intentional operation of the switch is accomplished by a pull on the lever to unlock it and permit its movement to the desired position.

Another Cutler-Hammer "first" for Aircraft Designers

Cutler-Hammer now offers the first line of Lever Lock Switches ever engineered for one hole mounting. Lever Lock to prevent accidental operation *without* cumbersome switch guards that obstruct panel visibility. One Hole Mounting to conserve panel space and provide maximum areas for panel markings.

These are typical Cutler-Hammer Aircraft Switches . . . top-quality construction, expertly engineered. Positive snap action with dependable contact pressure in the closed position and reliably secure contacts in the open position even under the severe shock and vibration encountered in combat aircraft service. The lever seal is of special silicone rubber, engineered to outlast the operational life of the switch. The seal is unaffected by ozone or sunlight, oil or water, or extreme temperatures, either high or low.

Cutler-Hammer Lever Lock One Hole Mounting Aircraft Switches are available in single, double or four-pole constructions . . . single or double throw, with or without center "off" position. Designed for minimum parts and weight. They solve many aircraft design problems. Be sure you have complete data *now*. Write or wire today.

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What you should know about Cutler-Hammer

Cutler-Hammer has long held the respect of the aircraft industry because this company has been *part* of the aircraft industry for 35 years. It has never been an opportunist supplier. It has *pioneered* the designs others have followed. It has sought to serve, not merely sell. It has been in the forefront of all cooperative activity in standardization and long-range planning. It has supplied complete lines of equipment, not merely the items of widest use and most profitable manufacture. Today, as for the decades past, Cutler-Hammer engineers are working closely with the aircraft industry's leaders . . . thinking ahead, planning, designing and building for the future. Here is the record:

1920 Cutler-Hammer designed and manufactured the first line of switches ever created specifically for use in aircraft.

1938 Cutler-Hammer designed and manufactured the first d-c power relays ever created specifically for use in aircraft.

1943 Cutler-Hammer designed and manufactured the first a-c power relays ever created specifically for use in aircraft.

1949 Cutler-Hammer started development of the first environment-free power relays for use in aircraft.

1953 Cutler-Hammer submitted samples and certified test reports on the first hermetically sealed power relay to WADC and Bu. Aer. Cutler-Hammer configuration was adopted as industry standard by ASG.

1955 Cutler-Hammer designed and manufactured the first one hole mounting Lever Lock aircraft switches.

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AIRCRAFT CONTROL
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Crusaders, armed with cannons and rockets, are designed to sweep the skies of enemy aircraft and extend the striking power of our fast-moving task forces.

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FUEL LOAD LIMIT CONTROL for the Viscounts

. . . Another SIMMONDS Pacitron "First"

Something *new* has been added to precision airline operation. PACITRON now makes provision for the use of *load limit control,* the automatic control of fuel taken aboard in accordance with flight plan requirements. Simmonds advanced electronic fuel gaging systems are now flying as standard equipment on the new Vickers Viscounts for U. S. and Canadian Air Lines. PACITRON capacitance fuel gage systems were specified to furnish these new turboprop transports with the most accurate method of measuring and managing fuel.

In addition to *load limit control,* PACITRON can include these additional fuel management functions: center of gravity control by fuel transfer or controlled usage, level switching signals, totalization and telemetering for remote readings.

Simmonds gages were also specified for measuring the water-methanol systems on the Vickers Viscount. In addition to fuel and water-methanol, Simmonds equipment has been successfully used for gaging engine oil, nitric acid and other hard-to-measure liquids.

Simmonds continues as "first in electronic fuel gaging."

The Extra Engineer—When Pacitron fuel gage system provides fuel management as well as fuel measurement.

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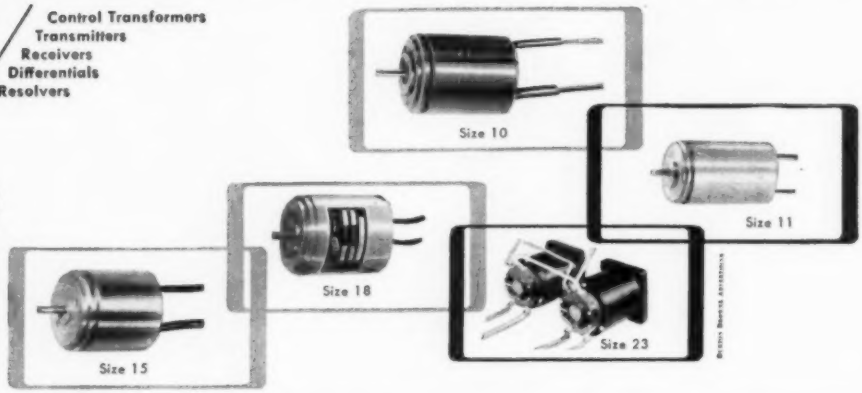

TYPE SYNCHRO	SIZE	OSTER TYPE	Frequency C.P.S.	Input Rotor Volts	Input Rotor Amps	Input Rotor Watts	Output Stator Volts	Input Stator Volts	Input Stator Amps	Input Stator Watts	Output Rotor Volts	Rotor Resistance Ohms	Stator Resistance Line to Line Ohms	Null Voltage	Angular Accuracy Maximum Spread
Control Transformer	10	3G-4055	400	26	0.030	0.30	11.8	11.8	0.060	0.20	21.3	160	45	0.050	30′
Control Transformer	10	3G-4079	400	26	0.008	0.10	11.8	11.8	0.018	0.10	20.3	510	200	0.050	30′
Transmitter	10	3G-4075	400	26	0.180	1.4	11.8	—	—	—	—	25	11	0.070	30′
Receiver	10	3G-4059	400	26	0.180	1.4	11.8	—	—	—	—	25	11	0.070	1½°
Differential	10	3G-4071	400	—	—	—	—	11.8	0.070	0.30	11.8	90	45	0.050	30′
Resolver	10	3G-4063	400	26	0.033	0.40	11.8	11.8	0.050	0.20	18.0	235	42	0.050	30′
Resolver	10	3G-4067	400	26	0.011	0.10	11.8	11.8	0.018	0.10	20.3	450	165	0.050	30′
Control Transformer	11	2C-4105	400	26	0.040	0.030	11.8	11.8	0.085	0.19	22.5	91.5	14.2	0.050	20′
Transmitter	11	2C-4125	400	26	0.150	0.80	11.8	—	—	—	—	20	4.3	0.050	20′
Transmitter	11	2C-4123	400	26	0.230	1.0	11.8	—	—	—	—	10.3	4.0	0.070	20′
Control Transformer	15	2G-4005	400	26	0.065	0.40	11.8	11.8	0.150	0.40	21.4	40	10.2	0.050	15′
Transmitter	15	2G-4025	400	26	0.225	1.25	11.8	—	—	—	—	9.5	3.8	0.070	20′
Receiver	15	2G-4009	400	26	0.10	0.45	11.8	—	—	—	—	16	6.7	0.070	45′
Differential	15	2G-4021	400	—	—	—	—	11.8	0.325	0.9	11.8	—	—	0.040	20′
Differential	15	2G-4041	400	—	—	—	—	11.8	0.120	1.3	11.8	14	10.2	0.050	15′
Resolver	15	2G-4017	400	26	0.014	—	18.0	18.0	0.015	—	21	239	180	0.050	40′
Transmitter 12 Power	18	3H-3309	400	26	0.77	2.3	11.8	—	—	—	—	1.032	0.675	0.050	20′
Differential	18	3H-3301	60	—	—	—	—	90	0.070	2.0	90	730	385	0.125	24′
Transmitter	23	3J-4222	60	115	0.120	3.2	17.0	—	—	—	—	140	8.3	0.050	30′

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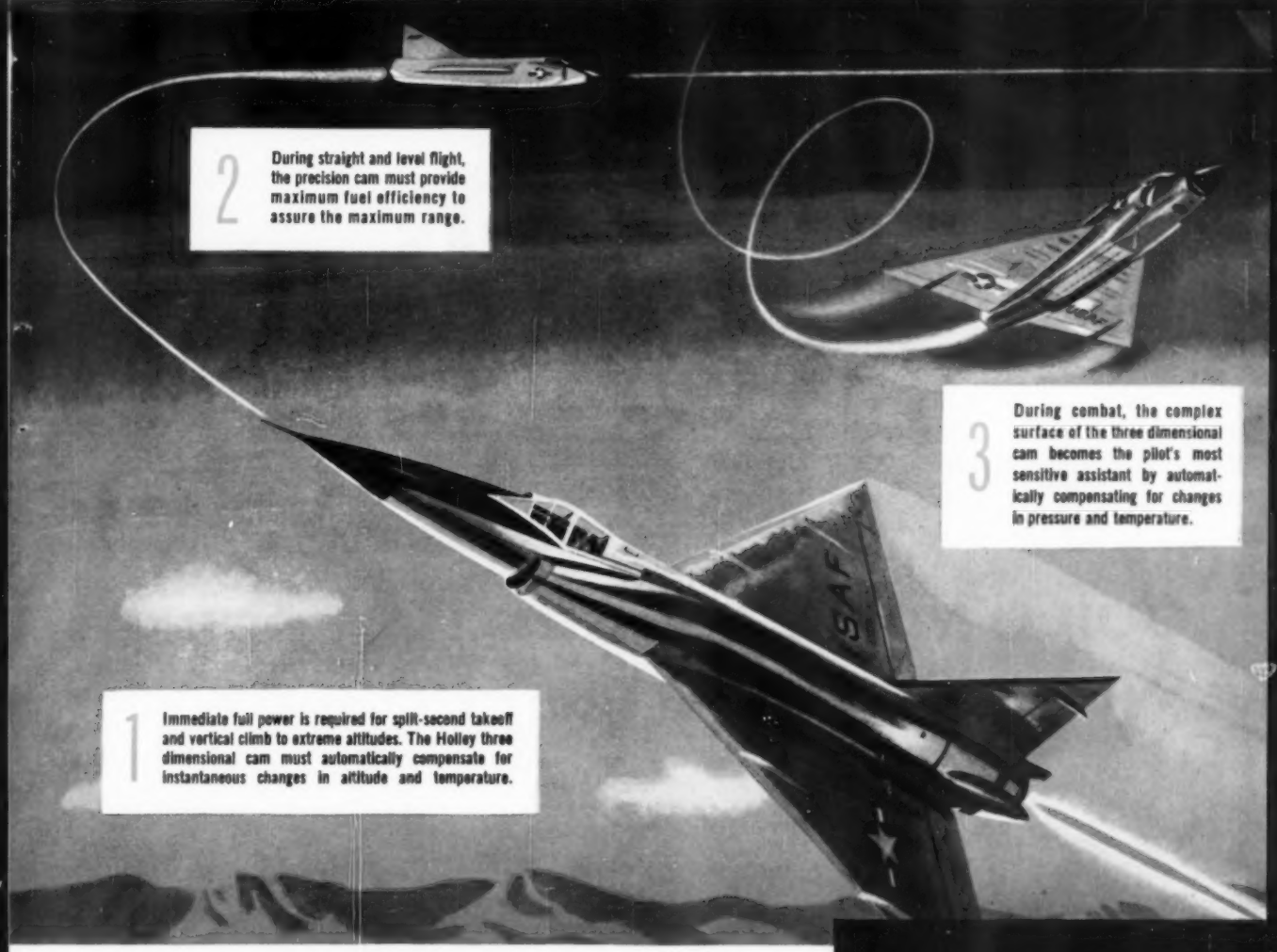
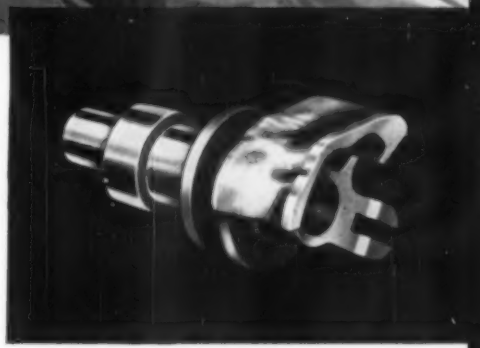

2 During straight and level flight, the precision cam must provide maximum fuel efficiency to assure the maximum range.
3 During combat, the complex surface of the three dimensional cam becomes the pilot's most sensitive assistant by automatically compensating for changes in pressure and temperature.
1 Immediate full power is required for split-second takeoff and vertical climb to extreme altitudes. The Holley three dimensional cam must automatically compensate for instantaneous changes in altitude and temperature.

How the Holley three dimensional cam functions as an automatic co-pilot

The job of the Holley Power Control for jet aircraft is to sensitively control engine power according to the pilot's requirements and, at the same time, make automatic adjustments for split-second variations in altitude, pressure and temperature. The "brain center" of advanced Holley controls is a three dimensional cam which is so contoured that it can adapt itself to all combinations of atmospheric temperature and pressure, from Thule to the Equator and from sea level to extreme altitudes.

In addition to the automatic compensations made for the pilot by the three dimensional cam, it interprets the pilot's request for changes in power. It's the most important link between cockpit and engine.

The three dimensional cam, like the power control itself, is designed, engineered and manufactured by Holley—one of the world's foremost power control manufacturers.



Typical "brain center" of a Holley aircraft engine control. Note the delicate machined surfaces. Each plays a vital role in mechanically regulating the engine under varying conditions.

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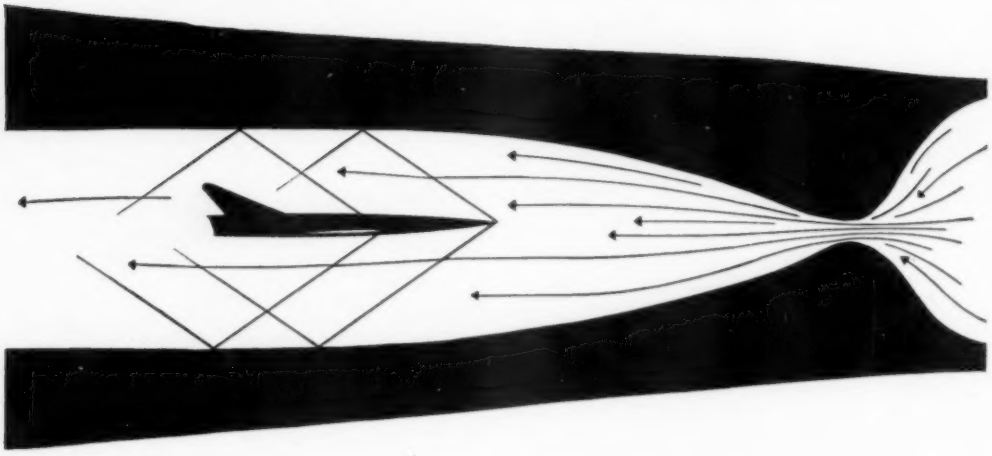

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Military security prevents more adequate description of the NAVAHO and other missile studies and proposals in development at North American. For a fuller explanation of the opportunities open to you, please contact North American's Missile Development Engineering.

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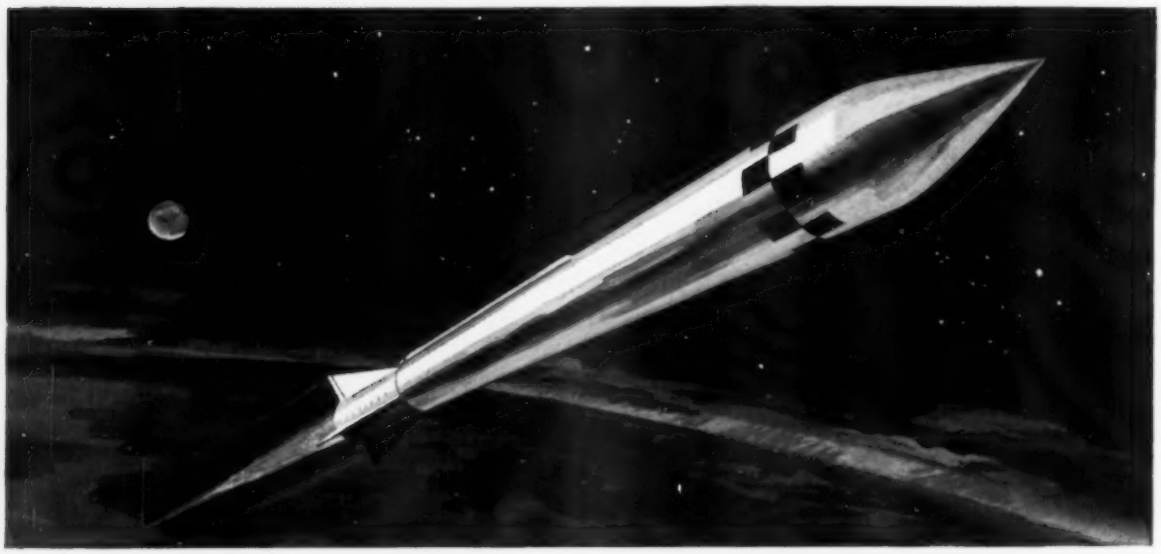

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The success of the Corporal is typical of the progress in guided missile technology which had its beginnings at JPL in the first early rocket experiments in 1940. Since then the Laboratory has grown to occupy an 80 acre site in the San Gabriel mountain foothills north of Pasadena and is staffed by the California Institute of Technology.

In missile development, JPL maintains a broad systems responsibility. For example, in the Corporal program, from earliest ideas to production engineering – from research and development in electronic guidance, propulsion, structures and aerodynamics, through field problems and actual troop use—full technical responsibility rests with JPL engineers and scientists.

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AIRCRAFT MANUFACTURE

PROBLEM	ANSWER	DESCRIPTION
		ALUMINUM CLEANING
All-purpose aluminum cleaning	**ALTREX***	A nonetching, soak-tank aluminum cleaner for rapid removal of marking inks and soil from aluminum alloys.
Deoxidizing aluminum prior to spot welding	**2487**	Room temperature deoxidizer for removing oxide films and reducing contact resistance of aluminum alloys to proper welding requirements of less than 50 microhms.
Descaling heavily scaled 61ST aluminum	**A.E.**	An excellent hot etch for descaling heavily-scaled 61ST aluminum. Removes scale and reduces contact resistance to proper welding range.
		MAGNESIUM CLEANING
Heavy-duty soak cleaning	**W.L.G.***	A versatile, heavy-duty soak cleaner for removing heavy oils, greases and drawing compounds. Phosphated to condition water—silicated for better cleaning action. No soap scums!
Alkaline cleaning	**ALTREX***	For cleaning aluminum and magnesium in the same tank. Eliminates soap scum in hard water. Removes most oil, drawing and stamping compounds.
		STEEL CLEANING
Heavy-duty soak cleaning	**W.L.G.***	A versatile, heavy-duty cleaner for removing greases, oils, and drawing compounds. Cleans heat-treated, oil-quenched stainless steel.
Heavy-duty electrocleaning	**F.S.***	For cleaning steel prior to plating; removing carbon smut when used with reverse current; cleaning magnesium, copper, bronze, and iron castings.

How Wyandotte's research-developed cleaning products

		SPRAY BOOTHS
Water-wash spray booths	**FLOTE**	A new product for water-wash spray booths. Eliminates tackiness and sinking paint sludge. Prevents clogging and back wall buildup.

AIRCRAFT MODIFICATION AND MAINTENANCE

PROBLEM	ANSWER	DESCRIPTION
		ALUMINUM BRIGHTENING
Removing surface corrosion residues	**1-2767**	A medium-duty brightener. Removes surface corrosion residues. Brightens without corroding surfaces.
Rapid removal of tarnish and corrosion from aluminum	**PHOS-IT**	A rust remover and metal conditioner for rapid removal of tarnish and corrosion from aluminum. Also, for preparing aluminum, iron, steel, and zinc for painting.
		CARBON REMOVERS
Cold tank carbon removing	**P-1075**	A nonflammable cold tank carbon remover for grease, oil, carbon deposits from jet and piston engine parts. Noncorrosive—excellent for stripping paint from base metals.
Carbon removing	**SUPERSOLVE**	A cresol-soap-type carbon remover. Meets Naval Bureau of Aeronautics Specifications. Safe on steel, plated steel, aluminum, copper, cadmium, and other aircraft metals.
		AIRCRAFT EXTERIORS
Emulsion cleaning	**1-2364**	An outstanding emulsion cleaner—meets Specifications MIL-C-25174 and MIL-C-7122 (AER)—will not craze plastics. Excellent for white paint.
		EXHAUST STAINS
Carbon removing	**SPRAZEE***	A heavy-duty paint stripper—excellent for removal of heavy, caked and baked-on carbon in the exhaust area.
Removing exhaust stains	**No. 20**	For removal of exhaust stains. Prevents corrosion in exhaust-stained areas. For stubborn stains, use without diluting.
		INTEGRAL FUEL-TANK DESEALING
Removing sealing compounds	**No. 2789**	For removing all types of sealing compounds. Especially active in removing polysulfide polymers.
Tank spotting	**1-1953-C**	Apply by brush on spots or patches of sealing compound not removed in normal desealing operations. Swells sealant and breaks bond-to-metal, makes removal easy.
		PAINT REMOVERS
Paint removing	**SPRAZEE***	A heavy-duty, fast-acting, free-rinsing stripper. Safe on aluminum, magnesium, steel, and other aircraft metals.
Paint removing	**P-1075**	Superior tank-type remover for aircraft finishes.
		OIL AND WATER ABSORBENT
Floor absorbent (anti-slip)	**ZORBALL**	The safest, lowest "use-cost," all-purpose floor absorbent. Absorbs both oil and water without breaking down. Lasts longer, goes further.

*Reg. U.S. Pat. Off.

Photo: Courtesy Boeing Airplane Company, Seattle, Washington

help you shorten maintenance time, reduce cleaning costs

Wyandotte offers the aircraft industry a complete line of specialized cleaning products. There's a long list (see chart on opposite page) of these top-quality products, including: aluminum cleaners and brighteners, metal cleaners, emulsion cleaners, electrocleaners, carbon removers, deoxidizers, paint removers, tank descalants, and spray-booth compounds. In addition, Wyandotte makes a special line of cleaning compounds to meet government specifications. All of these products are backed by many years of Wyandotte experience.

Wyandotte service is complete—ranging from the operations listed at left to dishwashing, rug washing, and maintenance cleaning of buildings. We have experienced service representatives who have complete technical information on these cleaning operations.

Mail the coupon today. We will gladly show you how to use any of our specialized cleaning compounds to your best advantage. *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Also Los Nietos, California. Offices in Principal Cities.*

Wyandotte's new research laboratories are the most modern in the industry. They house the latest in aircraft and industrial testing equipment: cleaning and plating tanks, a multi-stage washer, burnishing barrels, polishing and buffing lathes, special equipment for working with radioactive tracers, and a wide variety of other equipment.

Wyandotte
CHEMICALS
J. B. FORD DIVISION

SPECIALISTS IN AIRCRAFT-CLEANING PRODUCTS

Wyandotte Chemicals Corporation
Dept. 2361
Wyandotte, Michigan

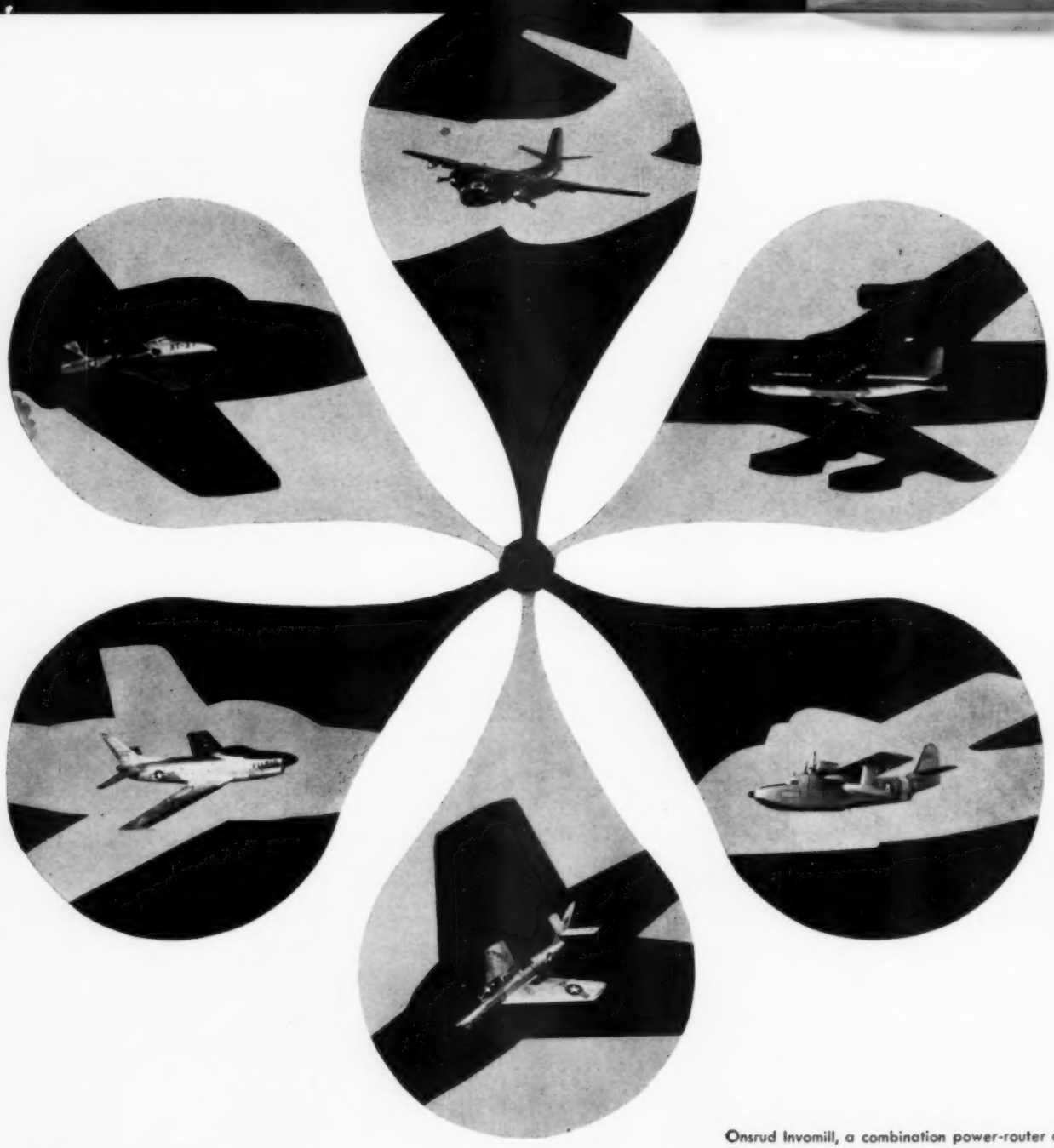
Please send more information on the following products:

Name_____ Title_____

Firm_____

Address_____

City_____ Zone____ State_____



*Shape of things that come— *from* TWIN COACH

Piston or jet..single or multi-engine...trainer...interceptor, triphibian or tanker transport —Twin Coach Aircraft Division is probably unique among America's great subcontractors in its ability to produce major assemblies for many different aircraft types.

That's because we're *aircraft* specialists. Twin Coach Aircraft Division's five plants are devoted *exclusively* to production of airframe major assemblies. We build no other products...do no other work.

This is important because it means your airframe assemblies are built by experienced aircraft specialists... *men whose one aim is to produce to specification, on schedule, at the lowest possible cost.*

Onsrud Invomill, a combination power-router and skin-milling machine that can remove up to 150 cu. in. aluminum per minute, is just one of many hundreds of modern, high-speed machines. AA-1629

TWIN COACH COMPANY
Aircraft Division
BUFFALO, N. Y.

Other divisions of Twin Coach Company make:
PONY EXPRESS TRUCKS • FAGEOL GASOLINE AND PROPANE ENGINES
• FAGEOL-LEYLAND DIESEL ENGINES • FAGEOL AEROJET ENGINES

Look to Scott for Oxygen Equipment of the future

Modern Scott Breathing equipment, now in prototype production, introduces a new concept of respiratory protection for passengers and crew during high altitude flight.

Keeping pace with modern jet transports now under construction, Scott engineering and research are continuously developing oxygen equipment that will be standard on the giant Jet-liners of the future.

"THE SHAPE OF THINGS TO COME"

Emergency Passenger Oxygen (illustrated).

Stewardess Pack (illustrated).

Diluter-demand Miniature Panel-mounting Regulators.

Miniature Reducing Regulators.

Trigger Valve to Activate Emergency Oxygen System.

Combination Oxygen outlets.

Today: Scott Products are the Standard of the Industry

OTHER SCOTT PRODUCTS

MC-3 Safety Disconnect • Miniature Automatic Pressure Breathing Regulators • Miniature On-off Valve and Oxygen Pressure Reducer Combination • Bailout Cylinder Assemblies • Partial Pressure Suit Systems • 8540 Oxygen Line Flow Indicators • Oxygen Demand and Constant-flow Masks • K-S Disposable Oxygen Masks • Light Aircraft Tailwheel Assemblies • Brake Cylinders • Parking Brake Valves • Control Wheels

SCOTT AVIATION CORP.

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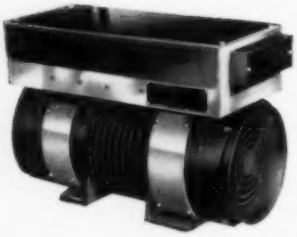
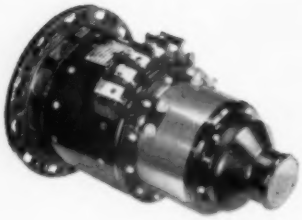
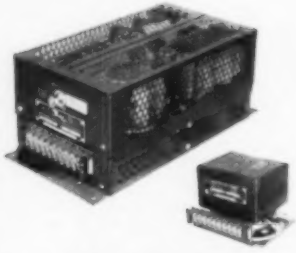


High-Altitude and Missile
INVERTERS



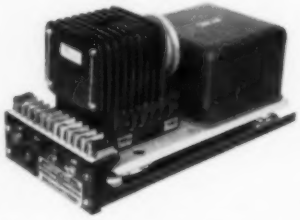
High-Temperature
AC GENERATORS



AC Voltage Regulators
(Magnetic Amplifier Type)
and
SYSTEM COMPONENTS

Special-Purpose Tubes
featuring
HARD GLASS TYPES

High-Temperature
DC GENERATORS



DC VOLTAGE REGULATORS
and
CONTROL PANELS

When it comes to special-purpose electron tubes, or electrical power equipment of the types shown above, you can be sure of getting top quality from Bendix Red Bank. That's because we offer the unbeatable combination of skillful design and expert engineering plus quality control over every step of manufacture. Call on us at any time for recommendations.

Write today for brochure detailing our engineering, production and service facilities. RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Sales and Service: 117 E. Providencia Ave., Burbank, Calif.
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Red Bank DIVISION
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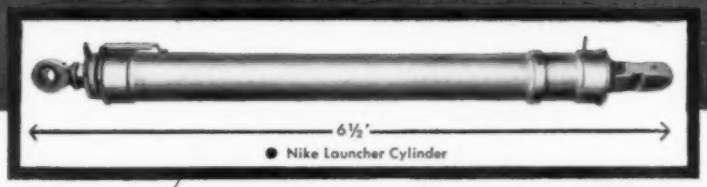
Bendix AVIATION CORPORATION

the sky's no limit!

TODAY, A LAUNCHER CYLINDER FOR THE NIKE! TOMORROW.....?

Whatever the need for precision units, INTERSTATE engineers will design and build them!

For almost two decades, INTERSTATE has been noted for quality of design, production standards and ability to meet exacting schedules. In the '30's, as one of the largest producers of light aircraft, INTERSTATE played a vital role in the development of America's aviation training program. During World War II, INTERSTATE produced over $50 million worth of material for the Armed Forces, including actuating cylinders that opened the bomb bay doors of the B-29 carrying the atom bomb over Hiroshima. In post war years, INTERSTATE has been a factor in precision aircraft parts manufacturing, as well as in production of airframe components. Today, products from our highly skilled engineering design group are used by every major airline throughout the world.

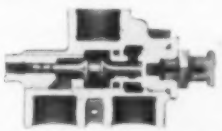


● Nike Launcher Cylinder

● AD-6 Navy Dive Bomber Fuselage

● Hydraulic Door-catch Cylinder

● Hydraulic Fuel-selector Valve



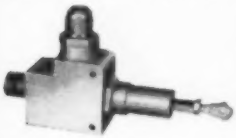
● Hydraulic By-pass Valve

● Hydraulic Actuating Cylinder

● Pneumatic Air Valve (rotating)

● Pneumatic Selector Valve

● Pneumatic Anti-G Blackout Valve



● Pneumatic Canopy Release Valve

● Ram Air Pressure Regulator

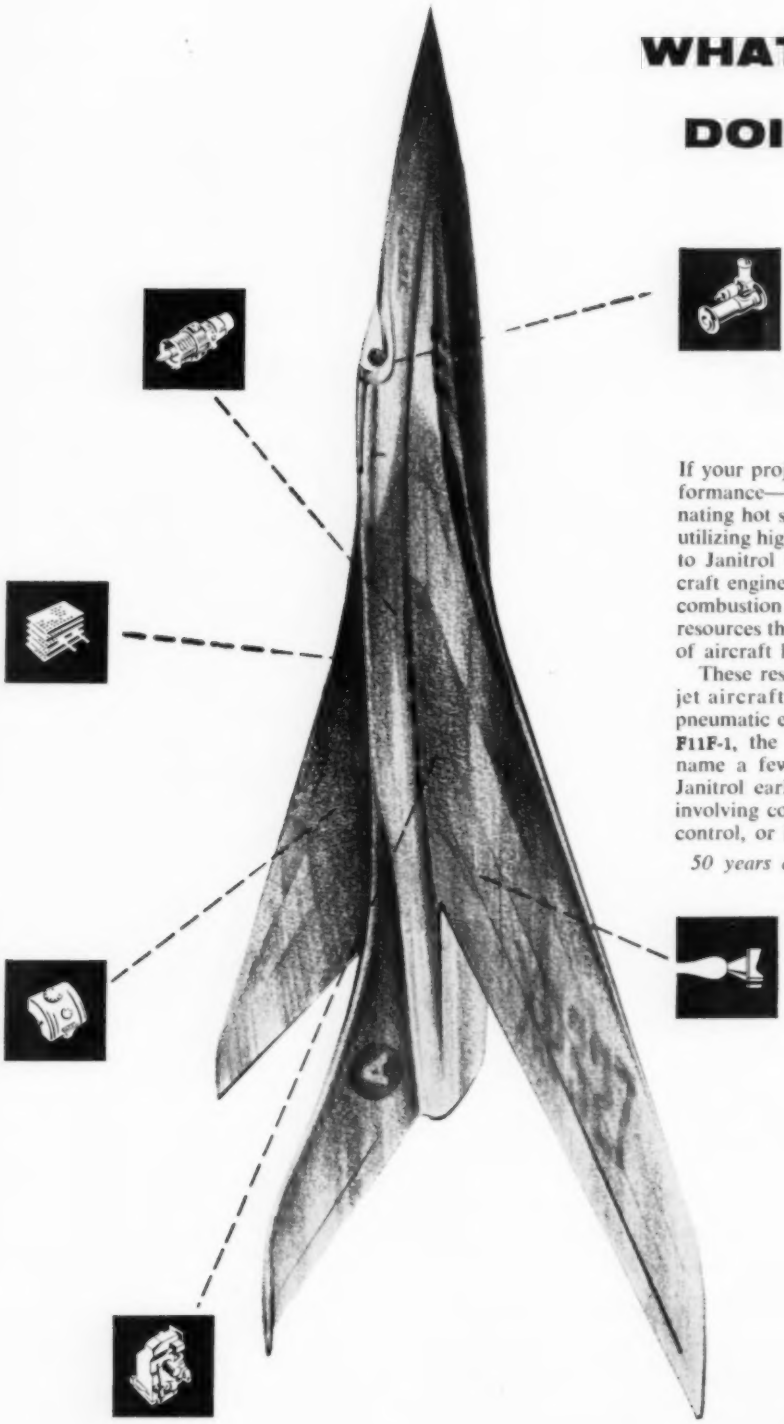
INTERSTATE has complete facilities for research, development and production of precision aircraft parts, including hydraulic components and fuel systems. Also at your service is our Environmental Laboratory with a new hydraulic test facility, for research and test of heat, cold, altitude and vibration phenomena under computed military specifications.

PHONE, WIRE OR WRITE FOR COMPLETE BROCHURE DETAILING OUR EQUIPMENT AND PRODUCTION BACKGROUND

Interstate ENGINEERING CORPORATION

(Dept. 50) 2250 E. Imperial Highway
El Segundo, California

WHAT JANITROL'S DOING IN JETS



If your projects involve the improvement of jet performance—boosting power without dry loss, eliminating hot spots to achieve higher combustion rates, utilizing high pressure air in new applications—a call to Janitrol will give you a head start. Janitrol aircraft engineers not only bring fresh thinking to new combustion problems; they can supply the proven resources that have made Janitrol the leading builder of aircraft heating equipment.

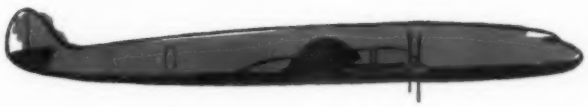
These resources represent a unique asset in other jet aircraft applications. Some of Janitrol's new pneumatic equipment is in service on the Grumman **F11F-1**, the Republic XF-105, and the RB-66, to name a few. So it's good business to check with Janitrol early in the design stage on any problems involving combustion, heat generation, heat and air control, or heat transfer.

50 years experience in combustion engineering

Janitrol

AIRCRAFT-AUTOMOTIVE DIVISION, SURFACE COMBUSTION CORPORATION, COLUMBUS 16, OHIO

DISTRICT ENGINEERING OFFICES: NEW YORK, 225 BROADWAY; WASHINGTON, D. C., 4650 EAST-WEST HIGHWAY; KANSAS CITY, 2201 GRAND AVE.; FORT WORTH, 2509 BERRY ST.; HOLLYWOOD, CALIF., 7046 HOLLYWOOD BLVD.; COLUMBUS, OHIO, 400 DUBLIN AVE.

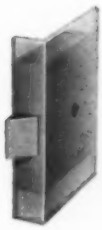
ACCEPTANCE  MUST BE

EARNED. THE BEST

PROOF OF THE EFFICIENCY,

QUALITY, AND

ECONOMY OF

ADAMS-RITE LOCKS  AND LATCHES

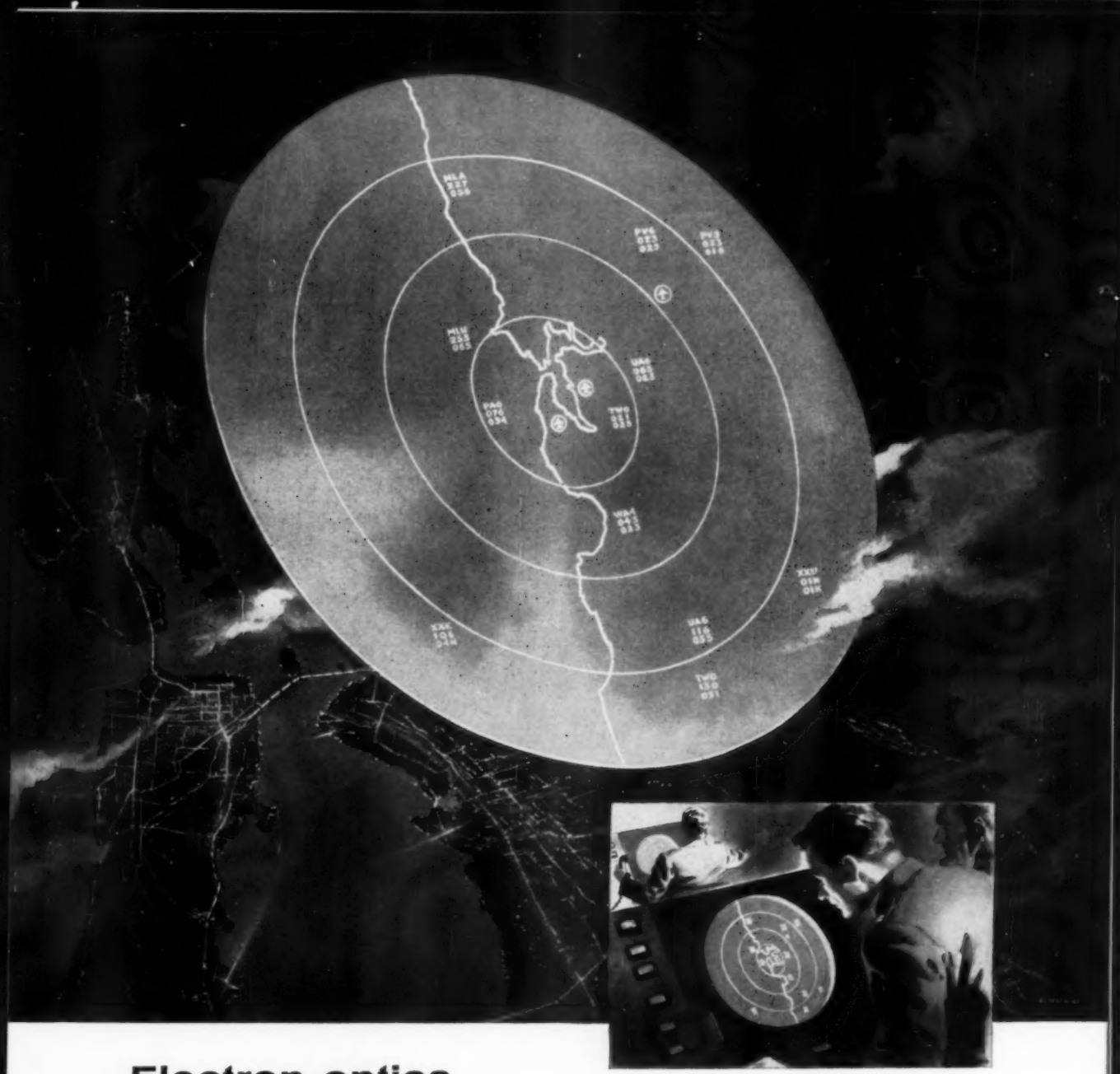
IS THE FACT THAT

EVERY MAJOR AIRCRAFT MANUFACTURER USES **ADAMS-RITE**

DOOR CLOSING DEVICES.

ADAMS-RITE MANUFACTURING CO., 540 W. CHEVY CHASE DR., GLENDALE 4, CALIF.

REPRESENTATIVES: EASTERN—Reciputi & Weiss, Inc., Amityville, N.Y. MIDWEST—George E. Harris & Co., 1734 N. Hillside, Wichita, Kan. Offices: St. Louis, Kansas City, Dallas.
CANADIAN—Railway & Power Engineering Co., Montreal. Offices throughout Canada.



Electron optics

In *Charactron*®, as shown above, the principles of a cathode ray tube have been refined with pinpoint accuracy and applied to the presentation of aircraft surveillance data in "SAGE" . . . the Continental Defense System.

The precision required in manufacture is of the highest order.

Heart of the tube is a circular matrix on the face of which, in a ¼" square, 64 minute code characters have been punched. The electronic beam, responding only to processed radar data, selects these characters individually, at speeds up to 10,000 a second—and displays them in groups, identifying targets by type, speed, altitude and track number.

This new tool, the *Charactron*® electron optic tube, has many applications besides that of air surveillance. We'd welcome the opportunity to consider any problem of *yours* which this latest development of precision work in electron optics might well help to solve.

STROMBERG-CARLSON COMPANY

A DIVISION OF GENERAL DYNAMICS CORPORATION

General Offices at ROCHESTER 3, N. Y.

minute men

WHEN SECONDS MEAN SURVIVAL, ground support equipment of unquestionable reliability is the indispensable factor. As a pioneer in all phases of ground support, CONSOLIDATED has developed units of broad application for maintaining missiles or piloted aircraft at a constant ready. Through design, development and manufacture, we have solved the most complex problems of providing self-propelled, multi-purpose units . . for towing, testing, servicing and starting guided missiles and jet aircraft . . . . . quickly, surely and under the most difficult operational conditions. Several of CONSOLIDATED's models are now being used extensively by the U. S. Air Force, Navy and Marines.

MODEL 2100 INCORPORATES HYDRAULIC, A. C., D. C. ELECTRIC, AND TOWING.

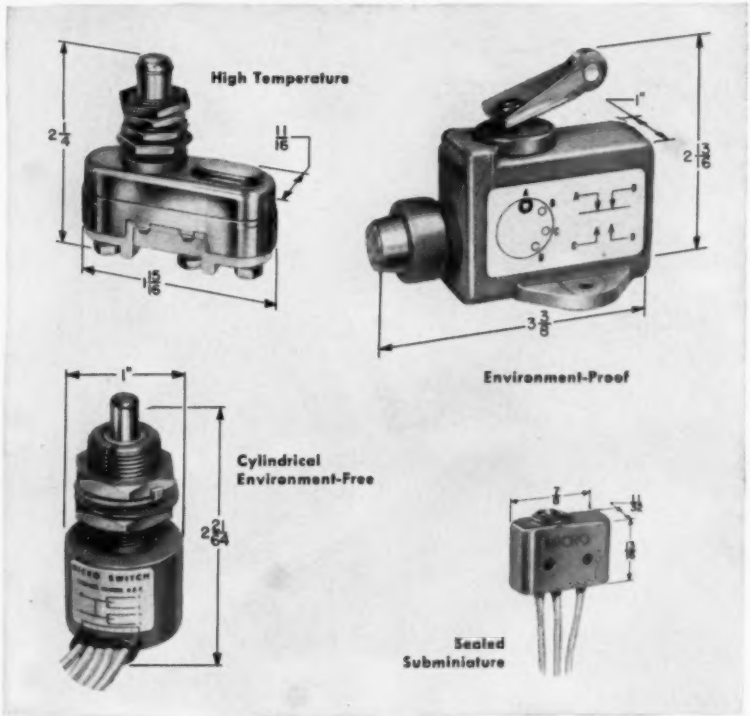
IN THE EXACTING FIELD OF GROUND SUPPORT, CONSOLIDATED HAS DEMONSTRATED ITS ABILITY TO MEET THE MOST COMPLEX DEMANDS

CONSOLIDATED
DIESEL ELECTRIC CORPORATION

STAMFORD, CONN. BRANCHES · DALLAS, TEX. · DAYTON, OHIO · SANTA ANA, CAL. · WASHINGTON, D. C.
IN CANADA · CONSOLIDATED DIESEL ELECTRIC CORPORATION · OTTAWA, ONT.

MICRO *precision switches*

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



A continuous flow of Precision Switch developments anticipate aircraft design needs

The chief function of MICRO SWITCH Engineering, both at the factory and in the field, is to be ready with the most dependable, most reliable precision switches for every aircraft design requirement.

Shown here are just a few recent developments that designers have found useful in a wide variety of applications as components for airborne equipment. Each is one of a "family" of switches to best meet specific needs. For more complete information get in touch with your nearest MICRO SWITCH branch office.

The High Temperature Switch operates satisfactorily in a temperature of from minus 50 degrees F. to plus 1000 degrees F. It has been found valuable as an aircraft component for use in extremely hot locations such as close to the afterburner in jet engine planes.

The Environment-Proof Switch shown is completely sealed and contains an inert gas to prevent atmospheric changes or severe environmental conditions from affecting switch operation. This switch is interchangeable with AN-3217-1 and AN-3217-2.

Cylindrical Environment Free Switch is a compact, completely sealed cylindrical shaped switch for use on landing gears, flaps or other exposed locations. It is equal in performance and has more versatility than switches several times its size and weight.

The Sealed Subminiature Switch is the smallest, lightest weight switch of this type available. It is completely sealed and designed to give trouble-free operation in a temperature range of from minus 65 degrees F. to plus 180 degrees F.

Electrical Ratings of switches shown

HIGH TEMPERATURE:

At 700°F

5 amperes (resistive) 28 volts d-c.

At 1000°F

2 amperes (resistive) 28 volts d-c.

ENVIRONMENT-PROOF:

Rating at 28 volts d-c.

15 amperes resistive, 10 amperes inductive, 5 amperes lamp load, 10 amperes motor load.

Rating at 115 volts a-c and d-c.

10 amperes a-c or 1 ampere d-c resistive; 10 amperes a-c or .5 ampere d-c inductive; 6 amperes a-c or 1 ampere d-c lamp load, 6 amperes a-c or 1 ampere d-c motor load.

CYLINDRICAL ENVIRONMENT-PROOF:

Rating at 28 volts d-c.

INRUSH:

24 amperes, normally closed and normally open.

AT SEA LEVEL:

4 amperes, motor and resistive; 3 amperes inductive.

AT 100,000 FT.:

4 amperes, motor and resistive; 2 amperes inductive.

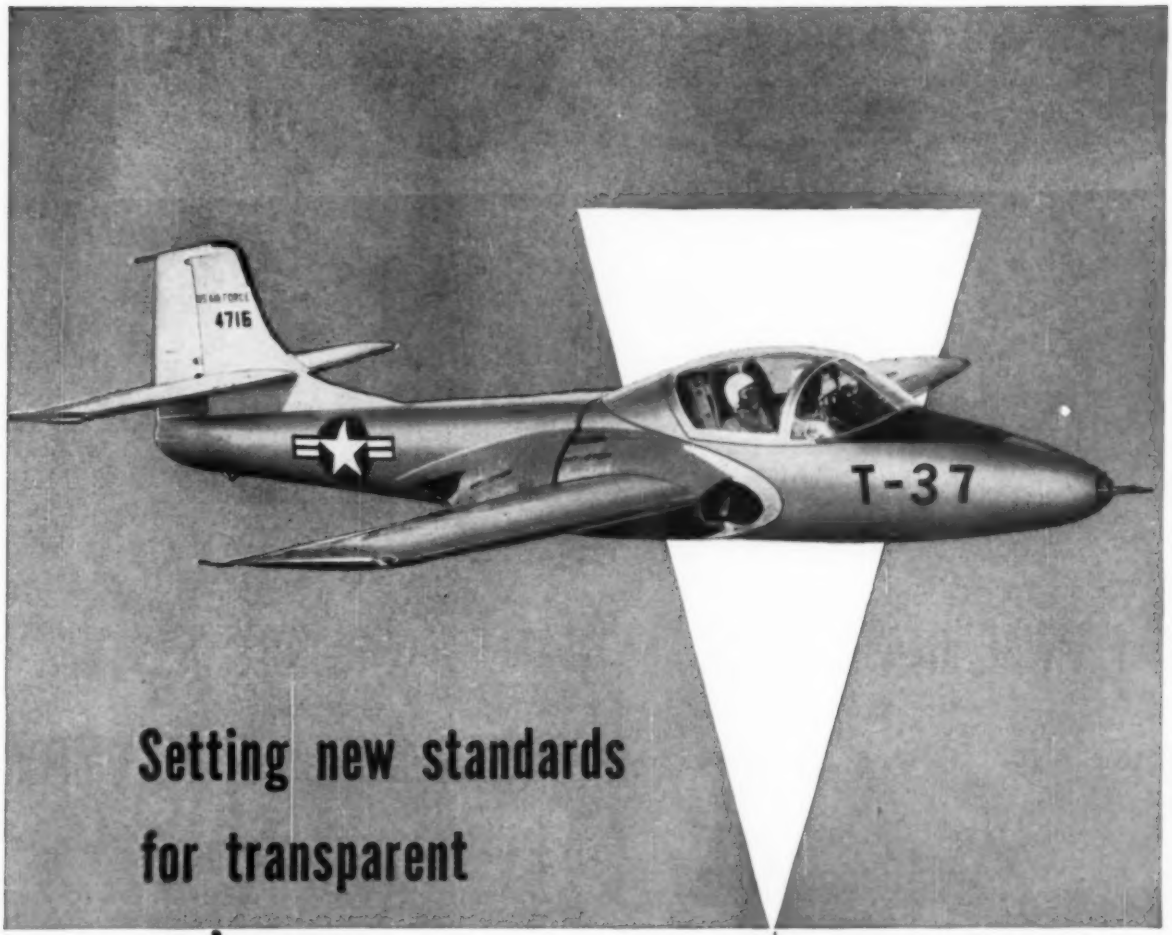
SEALED SUBMINIATURE:

30 volts d-c, 3 amperes inductive, 4 amperes resistive; maximum inrush is 15 amperes.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS



Setting new standards for transparent enclosures...

Plexiglas 55

On the Cessna T-37 and on many other military and commercial aircraft, PLEXIGLAS 55 is providing significantly longer service life for transparent enclosures. This grade of acrylic plastic is characterized by notably improved craze-resistance and a higher maximum useful service temperature. These advantages are combined with the traditional clarity, formability and weather-resistance of PLEXIGLAS—aviation's standard transparent material.

The list of planes now using PLEXIGLAS 55 includes:

Boeing B-47	**Douglas A4D, F4D-2**
Beech T-34	**Douglas DC-7, DC-6B, DC-6**
Cessna T-37	**Lockheed T-33B**
Convair F-102	**Martin XP6M-1, B-57B**

North American FJ-4, F-100

We will be glad to send you detailed information on PLEXIGLAS 55. For the planes of the future, we are working to raise the quality of transparent plastic to an even higher level.

PLEXIGLAS is a trademark, Reg. U.S. Pat. Off. and in other principal countries in the Western Hemisphere. Canadian Distributor: Crystal Glass & Plastics, Ltd., 130 Queen's Quay at Jarvis St., Toronto, Ontario.

Chemicals for Industry

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

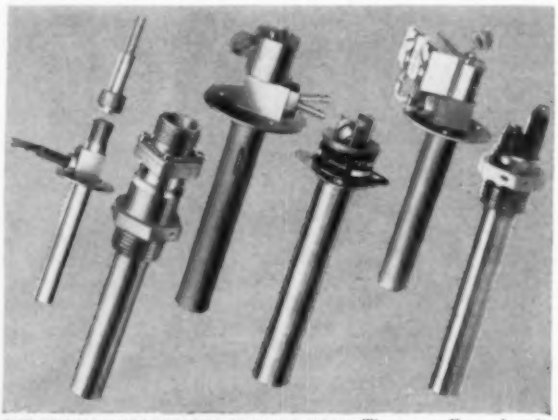
THE FAIRCHILD FLYING BOX CAR uses four Fenwal THERMOSWITCH controls in each of its eight combustion heaters for Lead Edge De-icing. Two of the THERMOSWITCH Heater Controls are set at 410°F for cycling and two are set at 490°F for over-heat protection. These Fenwal controls are located just outside the end of the heater in the pipe that connects the heater with the duct.

FENWAL HEATER AND VENTILATING CONTROLS ASSURE FLYING SAFETY AND COMFORT

In many of America's leading aircraft, safety and comfort are assured by Fenwal Heater and Ventilating Controls. These dependable Fenwal units are built to withstand the extremely high temperatures of modern aircraft under widely varying conditions of atmosphere, vibration and shock in accordance with applicable military and government specifications.

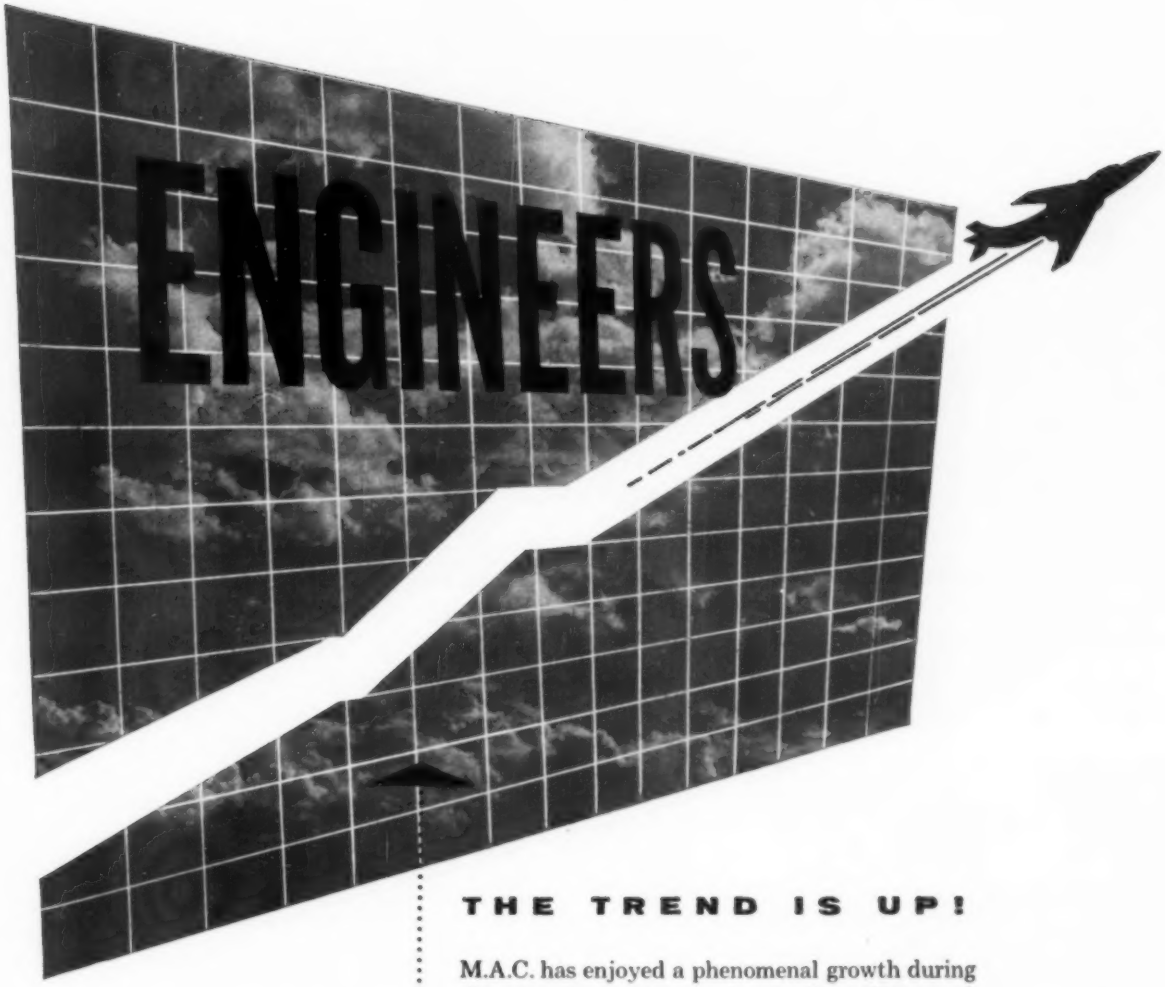
THE GLOBE-GIRDLING DOUGLAS DC-7 assures its passengers a safe, comfortable ride with Fenwal THERMOSWITCH® Heater Controls. Fenwal controls maintain a steady, comfortable temperature in passenger and crew cabins. The anti-icing heater of the DC-7 is equipped with primary and secondary cycling and over-heat THERMOSWITCH units. Fenwal rate-of-rise THERMOSWITCH units are located in the duct off the main cabin heater.

THE NEW CONVAIR 440 "METROPOLITAN" depends upon Fenwal THERMOSWITCH Heater Control devices as cycling thermostats and over-heat controls on its cockpit heater and in the exhaust augmentor control vanes. Highly resistant to shock and vibration, compact Fenwal THERMOSWITCH units meet the vigorous temperature control requirements that this plane encounters over its serviced routes throughout the world.



GET FENWAL HEATER CONTROL DEVICES. There are Fenwal units for all types of aircraft. The outer shell is the temperature sensitive element that actuates internal contacts the instant surrounding air reaches the set point. Write for complete data to **Fenwal Inc., Aviation Products Division, 123 Pleasant Street, Ashland, Massachusetts.**

Fenwal Controls Temperature ... *Precisely*



THE TREND IS UP!

M.A.C. has enjoyed a phenomenal growth during the past six years—and—the trend is still upward. We invite you to join us and grow with us.

New contracts have created four additional, complete project organizations in our Engineering Divisions within the past year. Many positions of technical leadership are still available.

FISCAL YEAR ENDING JUNE 30

1950		1955
$38,688,383	SALES	$154,588,816
$4.13	EARNINGS COMMON SHARE	$6.33
$62,695,281	BACKLOG	$305,438,023*
5,560	TOTAL PERSONNEL	13,786
961	ENGINEERS	2,654

* Backlog has since virtually doubled

Needed now are experienced engineers in:

DESIGN • AERODYNAMICS • AIR LOADS
STRUCTURES • CONTROL DYNAMICS (Flutter & Vibration)
MISSILE FLIGHT TEST—Dept. Head
MISSILE AEROELASTICITY & FLUTTER—Dept. Head

To secure our Annual Report and additional information write:

TECHNICAL PLACEMENT SUPERVISOR
P. O. Box 516 • St. Louis 3, Missouri

McDONNELL *Aircraft Corporation*

the world.

Champion-equipped F-100C Super Sabre sets supersonic speed record...822 mph!

Air Force Officer pilots North American jet to new world speed mark

This electronic timer, used to clock the record run, measures time down to a fantastic 1/100,000th of a second.

High-altitude scanner with telescopic viewfinder, specially designed to check on aircraft speed trials.

Flashing through the sky eight miles above California's Mojave Desert, an Air Force North American F-100C Super Sabre streaked to a new official world's speed record . . . a supersonic 822.135 miles per hour. The pilot twice guided the speeding ship over the 11-mile course . . . once at 773.644 mph, and once at an astounding 870.627 mph, for an average speed of 822.135 mph . . . bettering the previous record by more than 70 miles per hour!

The speedy Super Sabres are powered by Pratt & Whitney J-57 turbojet engines delivering over 10,000 pounds thrust. Champion Jet Igniters are original equipment on these engines, as on most leading jets. Champion dependability is important in jet engines, for in case of a "flame-out" the jet igniters must refire the fuel—quickly! Because Champion has an outstanding record for producing a dependable, quality product, leading manufacturers choose Champion to fire the flame that sends their jets flashing through the sky.

Dependability is equally important in piston engines. And for the most dependable spark plugs you can buy for aircraft or auto, get full-firing, long-lasting Champions.

ALWAYS DEPENDABLE

CHAMPION

SPARK PLUGS

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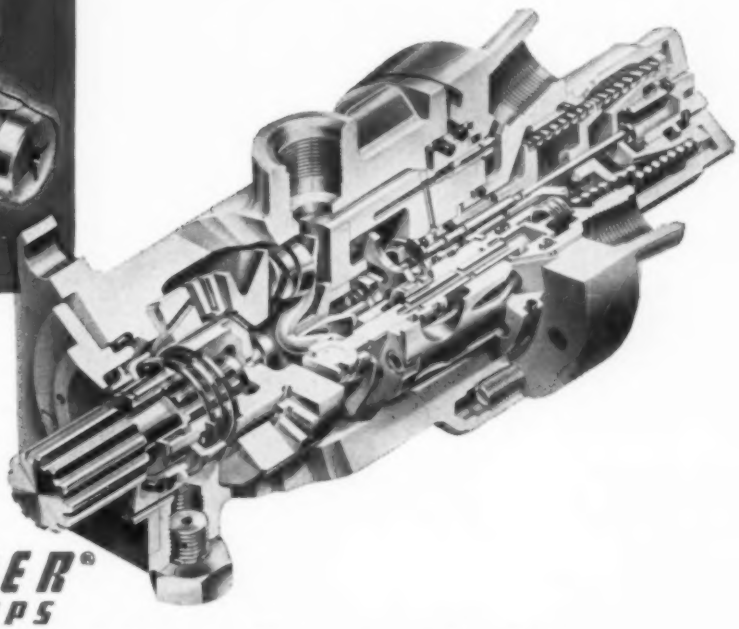

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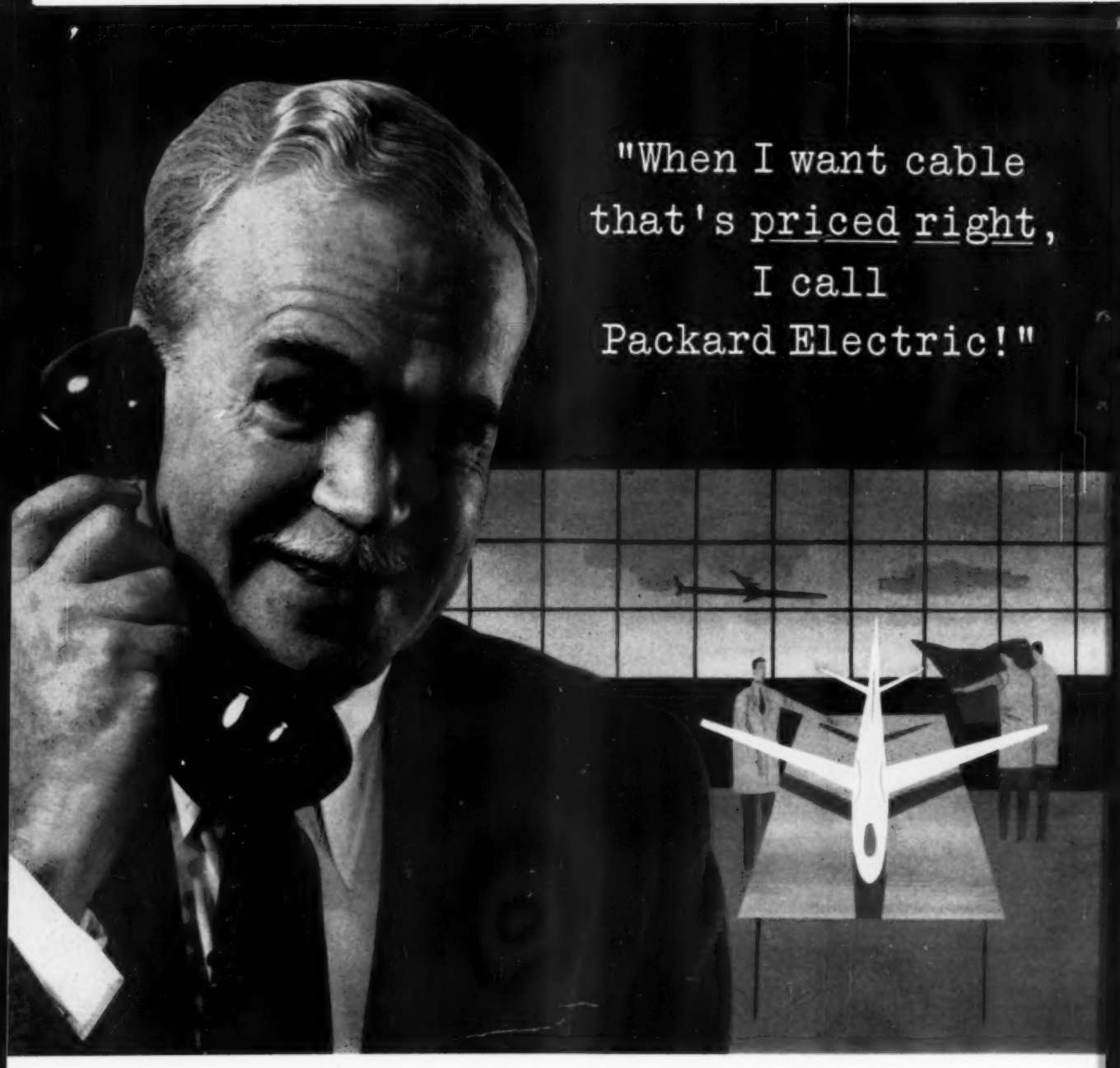

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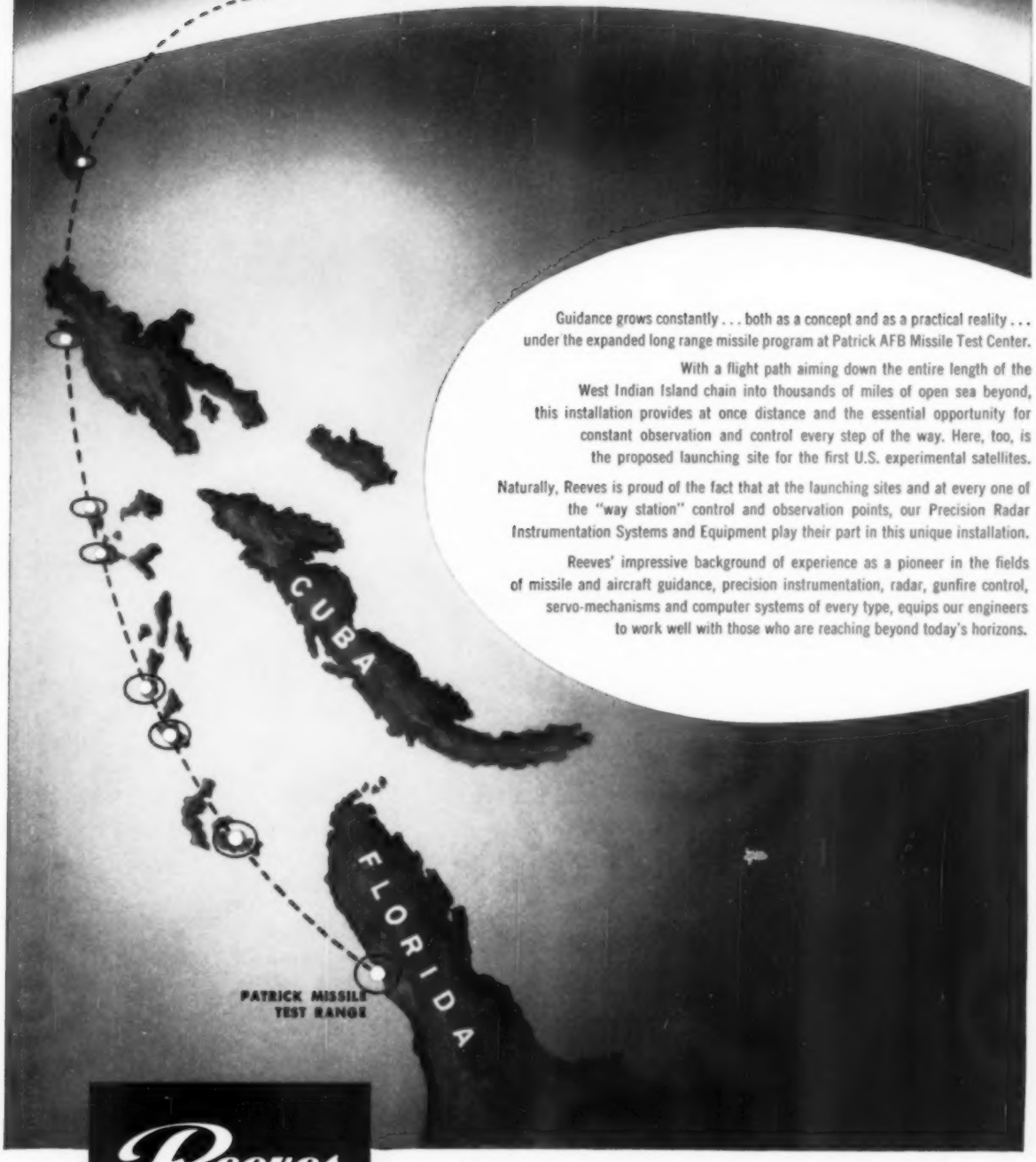

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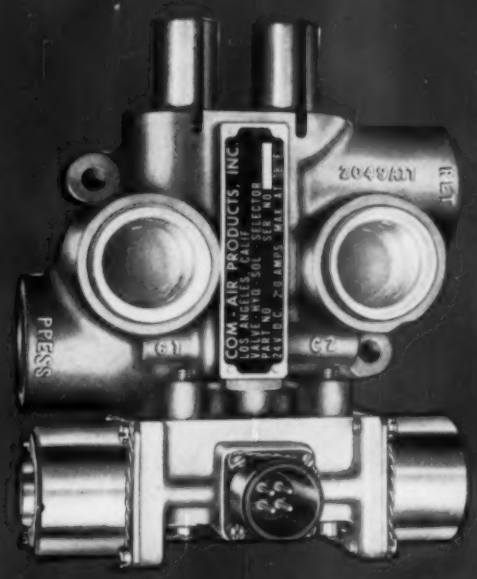

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No. 11
March 12, 1956

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● AIRPOWER FORECAST

Aviation Faces Changes in 1956

The aviation industry will take in gross revenues of over $10 billion during 1956. The military market for aircraft, missiles, avionics and supporting equipment will continue at about the $8.5 billion level it has maintained for the past three years. Major trend in the military market is the emergence of the missile branch of the industry into a billion dollar market during 1956 with strong prospects for increasing growth during the next 10 years.

Airline revenues will reach about $1.5 billion during this year, while commercial aircraft and helicopter sales will be close to $400 million

Profits for the airframe, missile and avionics manufacturers will remain close to the 1955 level. But there will be increasing divergence between the fortunes of individual firms as the military services emphasize purchasing from proved performers in their procurement and development policies.

Competition for military business will get stiffer and the more successful firms in technical development will get a larger share of the market. Firms whose technical development and production records are spotty can look for real trouble in maintaining their military market. Problem of renegotiation policy for profits accruing from military business remains unsettled and will affect the profits picture for individual firms.

TRANSPORT SALES TO RISE

AIRLINES WILL INCREASE their aggregate net income during 1956 but many airline managements will be fighting a tough battle against rising operating costs. This is particularly true for airlines awarded large new route mileage during 1955. Their net income picture will be influenced by heavy development expense, but the long term picture has greatly improved as a result of the additional routes.

Commercial transport sales will continue to rise during 1956 as the competitive situation forces more airlines to face their gas turbine re-equipment problems much earlier than anticipated.

Manufacturers of utility aircraft will enjoy their best year in history, with sales expected to top $100 million as business flying continues to expand. The helicopter industry faces technical growing pains that must be eased before renewed military and commercial enthusiasm can be anticipated. In addition stiff technical competition from improved surface transport and the short and vertical takeoff and landing developments in aviation introduce complicating factors in the helicopter's future.

This year will be marked by fundamental changes in the role of military airpower and the shape of national air policy. These changes will be reflected in intense public debate and increased technical competition within the aviation industry. These trends will be characteristic of the era of the atomic deadlock that has just begun.

NO ATOMIC MONOPOLY

THIS YEAR began with the end of the United States' monopoly in atomic and hydrogen weapons and in an intercontinental delivery system for these weapons. There is no longer any serious doubt in responsible Government circles that the tremendous research, development and production drive of Russian aviation during the past five years has produced atomic and hydrogen weapons and at least one intercontinental delivery system —the Bear turboprop bomber, first described in AVIATION WEEK on Feb. 15, 1954 (p. 12), which USAF now concedes has intercontinental-range.

Soviet leaders have made clear their intentions of developing other delivery systems for these weapons of area devastation. They already have a larger long-range jet bomber force than Strategic Air Command and are testing a ballistic missile of 900 miles range—about 700 miles farther than any ballistic missile yet fired by the United States.

It is clear that both the United States and the Soviet Union now have the power to blast each other's heartlands with weapons of unprecedented speed and violence. During this period when the opposing striking forces are about equal or

"We may have already arrived at a state of deadlock in which atomic weapons themselves impose a peace upon mankind that may well prove to be more reliable than the states of peace the world has tried to achieve in the past . . . . .

"In all of this there is a paradox, one that I hope will save civilization. It is as long as both sides have these terrible weapons and the means of delivering them there is no way for one side to initiate total war without disaster to itself. No matter which side decided to start total war, destruction would be so tremendous and so general that no one could dream of victory."

—Donald A. Quarles
Secretary of the Air Force

enjoy no wide, significant superiority over one another, paradoxically the prospects for world peace appear good. Neither major power would attempt to use its nuclear striking force on the other as long as its opponent possessed the power to retaliate in kind.

SIGNIFICANCE OF DEADLOCK

FOR THE AVIATION INDUSTRY the significance of the era of atomic deadlock lies in two of its dominant facets:

- **Military airpower** forces must be created and maintained in a state of instant combat readiness. For in an atomic war the critical phase will be fought within the first few days with the forces already in being.
- **Technological development** of new and superior aerial delivery systems must be pushed at an unprecedented pace to gain a clear-cut and significant superiority over any potential enemy.

Rise of Russian airpower at a rate much faster than anticipated by any Pentagon or White House policy maker has forced a basic re-evaluation of the American airpower policy. The "steady level" philosophy that guided airpower policy during the first three years of the Eisenhower Administration is no longer adequate in the face of the challenge now being offered by the Soviet airpower, particularly in its rate of development.

SOVIET CHALLENGE

GEN. NATHAN F. TWINING, USAF Chief of Staff, has made it clear in testimony before the Senate Armed Services Committee that if both USAF and the Russian air force maintain their current rates of progress, the Soviets will seize the lead in another two or three years. This makes it mandatory that American airpower accelerate its pace to maintain and increase its margin of superiority over its toughest competitor.

To accomplish this will take major changes in current airpower policy. The goals of any new airpower policy developed to meet adequately the Russian challenge should include:

- **Faster modernization rate** for the key airpower forces in being such as Air Defense Command and Strategic Air Command. Priority must be assigned for new equipment for these vital commands.
- **Faster and broader research** and development program that will permit full and rapid exploitation of all the new scientific possibilities that are appearing on the technical horizon.
- **Fundamental changes** in the organization and command of our total airpower resources.
- **Creation of mobile,** versatile tactical air forces that can handle the fringe type wars that are likely to spring up on the frontiers between the Communist bloc and the Free World.

CIVIL AIRLINE PROGRESS

Purchase of more than $1 billion worth of American turbojet transports by airlines of the world during the past six months has insured this country's continued leadership on the international commercial airways.

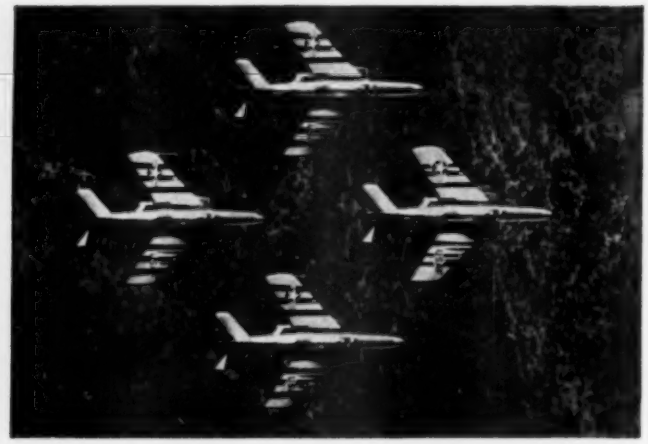
This year will see the first major steps in reorganizing the airways, airports, sales and maintenance philosophies of commercial aviation to meet jet age requirements. The commercial market for jet age supporting equipment will begin to develop strongly during 1956. Airport construction will continue to increase.

During 1956 the United States will continue to widen the margin of its world leadership in commercial aviation but will face the necessity of making major policy revisions in its military airpower program if it is to maintain and increase its present slim margin of superiority.

—ROBERT HOTZ

Aviation Week Color Portfolio

23rd INVENTORY OF AIR POWER



F-89D NORTHROP

RF-84F REPUBLIC

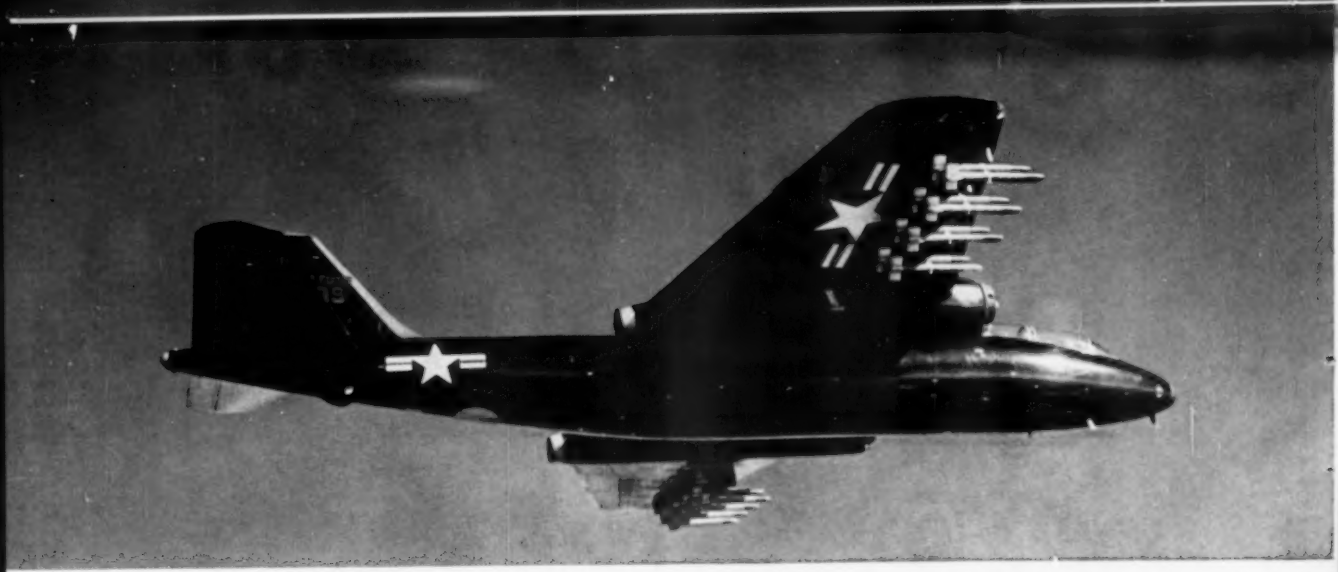
707 BOEING

B52A BOEING

F-102A CONVAIR

C-130A LOCKHEED

C-133A DOUGLAS



B-57B MARTIN

T2V-1 LOCKHEED

C-123B FAIRCHILD

P6M MARTIN

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F11F-1 GRUMMAN

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REGULUS
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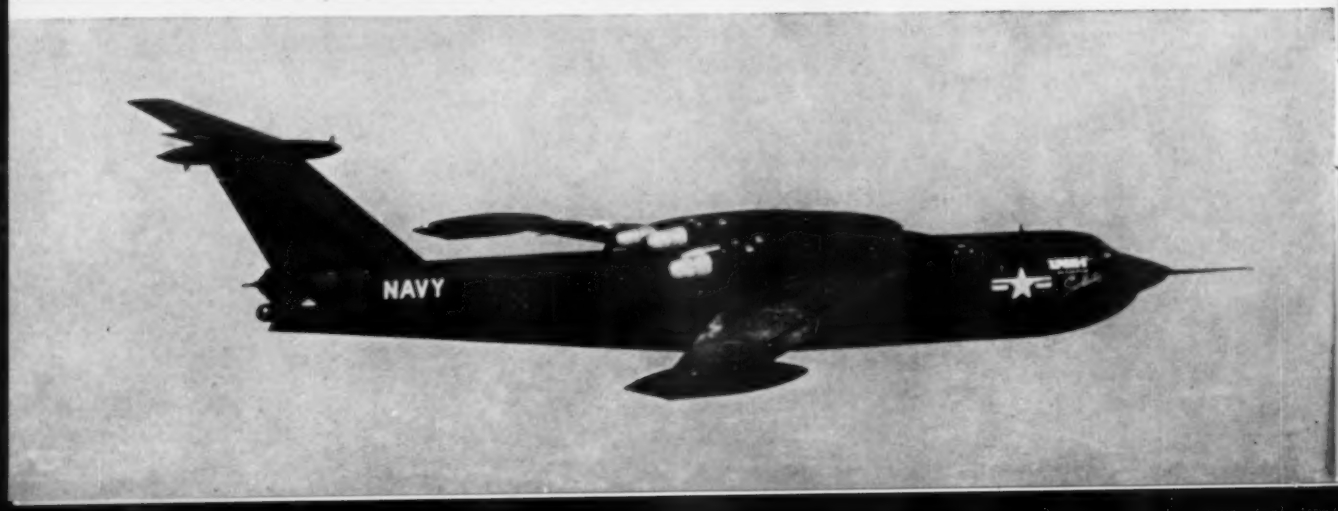

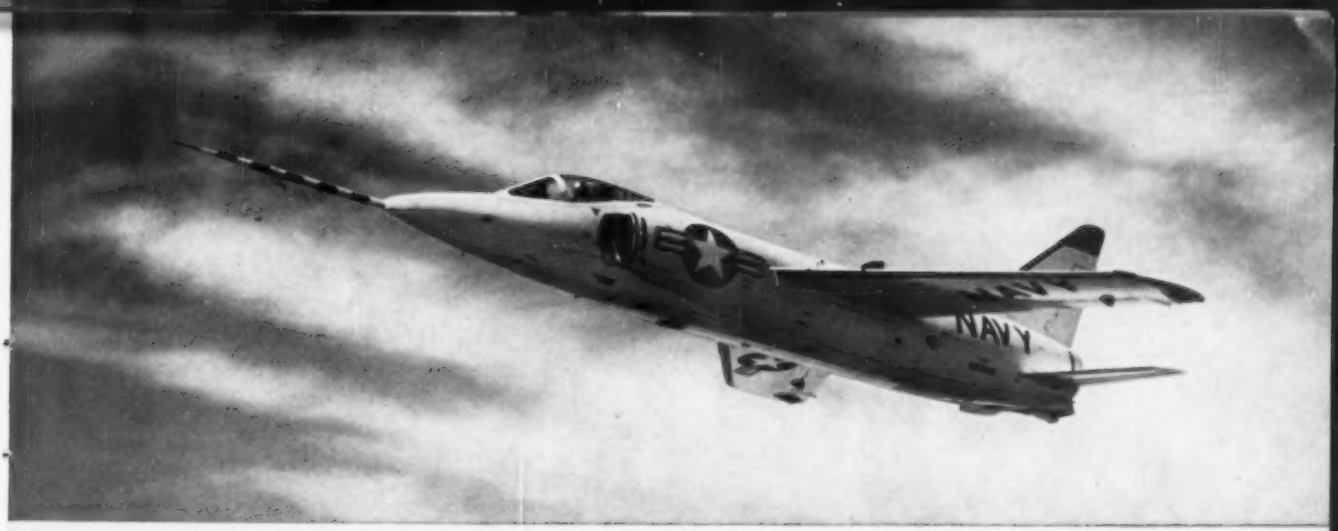
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MILITARY

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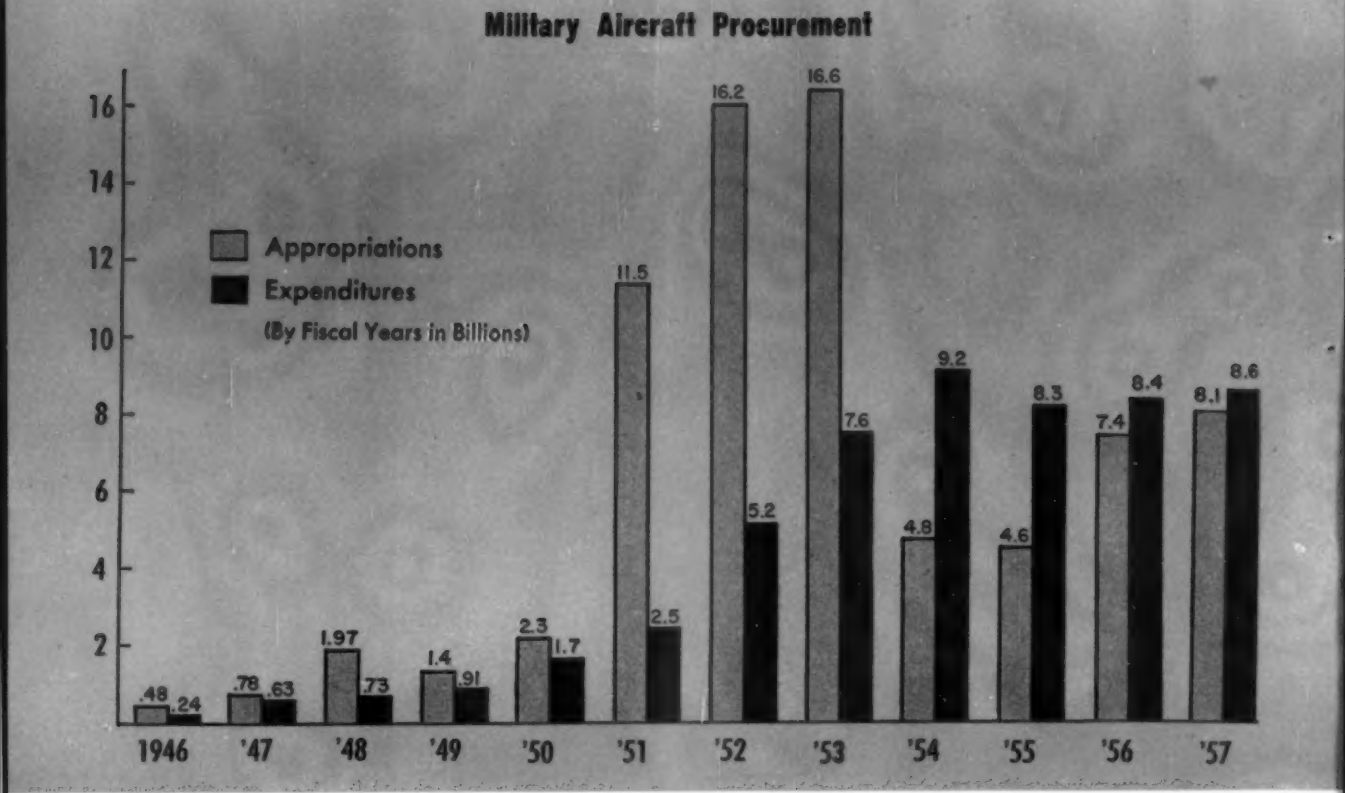


USAF Fights to Offset Russian Progress

By Claude Witze

U. S. Air Force today is deep in a fight for technological survival.

Victory is essential if America is to continue to hold the airpower necessary in this age of the Atomic Deadlock.

In this battle, USAF faces the dangerous combination of unbelievable progress in Russia and something bordering on complacency at home. There are suspicions here that the complacency is politically inspired.

So far as the aircraft industry is concerned, recent months have brought two outstanding reactions to this situation:

• **USAF's increasing emphasis on faster development.** Russia has shown herself to be one to three years faster than we in the development of complex weapons such as long-range bombers.

• **USAF's increasing emphasis on industry performance.** Quality and schedules must be maintained, says the Air Materiel Command.

There are other pressures coming out of USAF headquarters. Industry is urged to put more of its own money into research and development, for example. Manufacturers who take this advice are promised their reward in production contracts.

On the other hand, when USAF pays development costs through a special contract it feels free to give the production job to any capable manufacturer.

USAF's Awareness

Seriousness of the technological race with the Russians is clear to USAF at all operational, procurement and command levels.

The Air Force does not put the burden of winning this race on the aircraft industry alone. USAF's partnership with the aircraft industry is one that has worked well in the past and must work in the future. There is strong determination on both sides that this will be the case.

But, in 1956, there must be strong and fast action at a basic level before the team can produce.

It is a paradox that this action is not forthcoming and is bogged down in a government of businessmen. On top of the usual complications—basic research, development, checks and more checks, test flights, design changes, debates in Congress—there now appears the budgetary consideration in a new political connotation.

Russian Drive

Dr. James R. Killian, president of Massachusetts Institute of Technology, says that the Russians are driving so hard that they are willing, "in certain fields of critical importance, to let the scientists, rather than the budget officers, determine how much money will be spent and for what purpose. The kind of crash programs we had in wartime they seem to have now, at least in a limited number of fields."

The limited number of fields include the intermediate-range and intercontinental ballistic missiles. It is equally well known that USAF's leading scientists, civilian and military, feel strongly it is with funds put into research and development that the technological race must be won.

With the budget for Fiscal 1957 now before Congress, the question of whether scientists or budget officers will

BOEING RB-47K

McDONNELL F-101A ARMED WITH HUGHES' FALCON AIR-TO-AIR MISSILES

determine America's fate has become of primary importance. It surpasses the usual question of how many airplanes we will buy in Fiscal 1957, how many bases we will build and how well we will support USAF's operational needs.

Defense Answers

These questions are easily answered, although not entirely to the satisfaction of airpower proponents, by Defense Department officials. We have 127 wings in the Air Force, will have 131 by the end of next June and are promised 137 wings by June 30, 1957, the official goal.

USAF materiel deliveries will stay in the $6-to-$7-billion-a-year bracket for the next several years. Weapon systems are getting more complex and more expensive, so fewer units will be delivered while the Administration strives to eliminate the feast-or-famine tradition of the aircraft industry.

The plans for Fiscal 1957 call for about 1,900 new USAF aircraft. Subtract the normal attrition and you will find USAF will need hundreds more than this if it is to maintain and modernize its fleet.

This is only one of the points where Soviet progress becomes a factor in the constantly changing formula by which USAF judges its needs. There is strong evidence that the Reds have again outstepped our estimates of their capability and have an intermediate-range missile in or close to production.

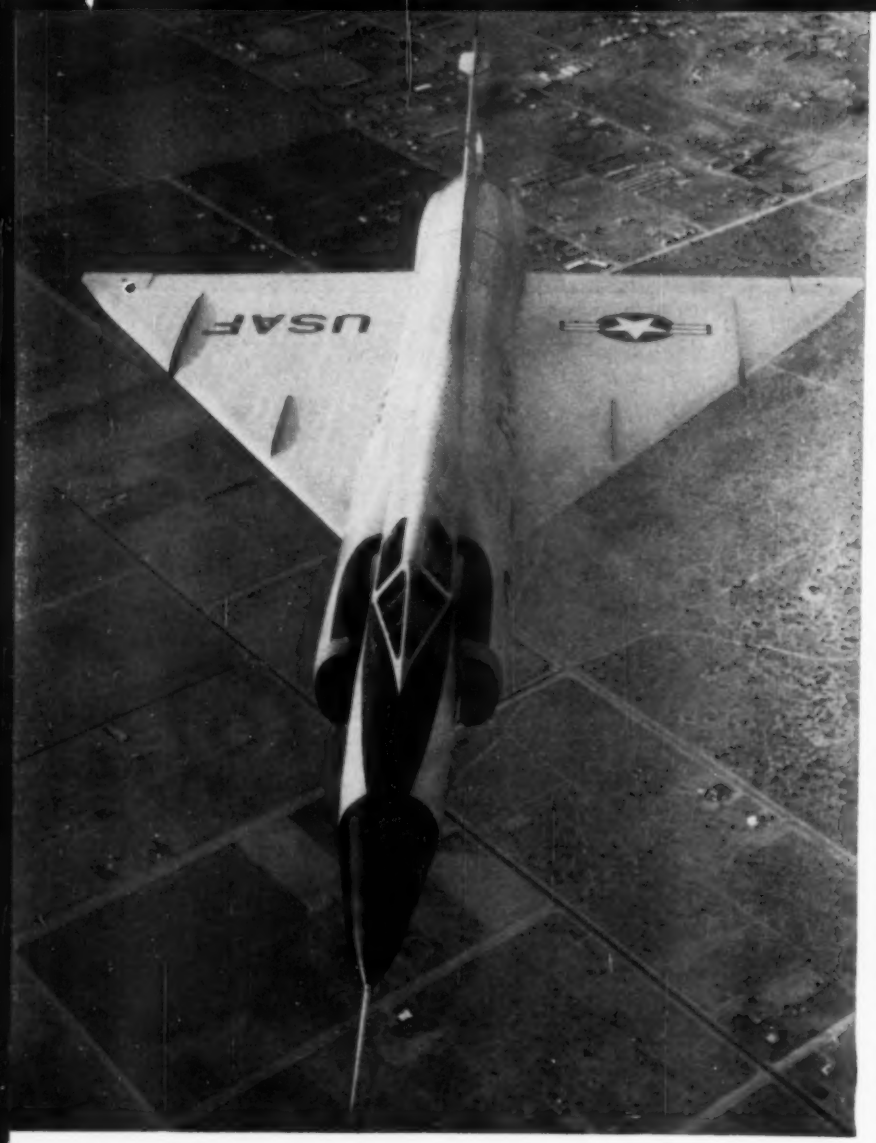
Dependence on B-52

This new threat to our bases overseas reduces the value of the B-47 medium bomber as a member of Uncle Sam's deterrent combination. It upgrades our dependence on that aircraft's big brother, the newer Boeing B-52, if we are to maintain retaliatory power.

Yet the B-52 is not in high-gear production. By USAF's own admission, it will be several years before the big jet has replaced the older Convair B-36 in operational units. The first replacements will start this spring.

It is highly significant that the United States enters the second atomic decade in a state of doubt about its continuing ability to deliver nuclear weapons. Top scientists are convinced that Russia may have an intercontinental ballistic missile before we do. Russia's project is 10 years old—as old as the atom bomb. We have sound advice from experts who have seen Russian industrial facilities that the Reds are adept at turning ideas into hardware.

When a project has urgency, they put all of the best into it, stint on neither manpower or money, and come



CONVAIR F-102A

Major USAF Commands

Air Defense Command
Ent AFB, Colorado

Air Materiel Command
Wright-Patterson AFB, Ohio

Air Proving Ground Command
Eglin AFB, Florida

Air University
Maxwell AFB, Alabama

Air Training Command
Scott AFB, Illinois

Air Research and Development Command
Baltimore, Md.

Headquarters Command
Bolling AFB, Washington, D. C.

Continental Air Command
Mitchel AFB, New York

Strategic Air Command
Offutt AFB, Nebraska

Tactical Air Command
Langley AFB, Virginia

Military Air Transport Service
Andrews AFB, Md.

Alaskan Air Command
Elmendorf AFB

Caribbean Air Command
Albrook AFB, C. Z.

Far East Air Force
Tokyo

Pacific Air Force
Hickam AFB, Honolulu

Northeast Air Command
Pepperrell AFB, N. F.

USAF Europe
Wiesbaden, Germany

USAF Security Service
Kelly AFB, Texas

out with a product that is competitive with the best we can do.

Russian Follow-Through

It has been suggested that Russia's greatest secret weapon may be its rapid and consistent follow-through from idea to practice.

Our intercontinental ballistic missile never has been out of conventional channels. There have been committee studies and coordination meetings, and an infinite amount of time spent wading through peacetime administrative channels. One top executive working on the project told AVIATION WEEK that even the shortage of skilled engineers paled to insignificance as a stumbling block when compared with the time lost getting people to make decisions.

These problems in the research and development field are not confined to the intercontinental ballistic missile or even to the missile family. They are hampering USAF today on a wide front. The most important policy modifications of the past year have been attempts to help solve them.

Challenge to Industry

USAF still presents the greatest challenge ever hurled at private industry by a government. In fact, its challenge has grown greater in the latter half of 1955 with these stern, sensible decisions:

- **Preliminary design studies** have been eliminated. An aircraft manufacturer's past performance, know-how and availability are the criteria under which he can become one of the small number invited to design a weapon system and build a mockup.
- **Contractors now face the threat** of profit penalties if they fail to meet performance specifications and delivery schedules. AMC will consider the risk assumed and relate price to the contractor's effort in the field of development. It will not permit a firm using government-furnished facilities to have a competitive advantage.
- **Air Research and Development Command** is lifting the wraps of secrecy from its Technical Program Planning Documents for a selected list of contractors. Aim of the ARDC program, which includes meetings at which contractors can get first-hand information about USAF development problems, is to encourage enterprise by disclosing more about the problems.
- **Evaluation of combat effectiveness** of new weapons has been speeded. In what amounts to an admission that USAF itself may at times resist change, a new regulation was necessary to force adoption of new practices and procedures so that the full value of missiles, for example, could be realized. Strategic, Tactical and Air Defense

USAF Planes on Hand

As of Jan. in the year below	Type				Totals
	Combat	Transport	Trainer	Communications	
1942	4,477	254	7,340	226	12,297
1943	11,607	1,857	17,044	2,796	33,304
1944	27,448	6,466	26,051	4,267	64,232
1945	41,961	10,456	17,060	3,249	72,726
1946	26,077	7,500	7,611	3,588	44,782
1947	17,186	4,538	6,297	2,014	30,035
1948	13,118	3,536	5,714	1,446	23,814
1949	9,031	3,712	6,177	1,148	20,068
1950	8,004	2,839	5,811	568	17,222
1951	8,159	2,859	5,961	358	17,337
1952	.....	.....	.....	.....	20,000*
1953	.....	.....	.....	.....	20,500**
1954	.....	.....	.....	.....	22,300***
1955	.....	.....	.....	.....	22,400
1956	.....	.....	.....	.....	26,429

* Includes 16,000 in active inventory and 4,000 inactive.
** Includes 16,500 active and 4,000 inactive.
*** Includes 17,700 active and 4,600 inactive.
SOURCE: USAF.

Commands were ordered to set up operational units and speed integration of new weapons into the USAF family.

Most important changes, from the standpoint of the technological race with Russia, probably have been in ARDC. Further improvements will be made in 1956. In addition to easing restrictions on circulation of the Technical Program Planning Documents, the Baltimore command is handing out its previously secret System Requirements on a selective basis.

Secrecy an Impediment

This effort aims to capitalize more fully on the best brains available in the American aircraft industry.

There has been a good deal of criticism that a security policy which maintains secrecy so strict that even America's top aeronautical engineers do not know the facts of life is a gross error. Secrecy impedes progress when there is no free exchange of ideas and developments among people vested with responsibility for more ideas and developments.

ARDC's approach, forced on USAF by the speed with which the Russians turn ideas into hardware, is to handpick a few highly qualified contractors and take them into its confidence. They will be kept fully posted not only on the state of the art but also on the details of USAF's war planning, inventory and requirements.

Performance in the area of development clearly is becoming the standard on which USAF will judge industry. ARDC's commander, Lt. Gen. Thomas S. Power, says we can meet the challenge of the fast-moving Russians only by putting our effort into "big jumps" and he has reorganized his own command to facilitate this approach.

Phase I Contracts

Second in importance to the new look at ARDC is the elimination of preliminary design studies in weapon systems procurement. Phase I contracts with a small number of hand-picked aircraft companies are substituted.

This policy got off the ground with the award of such contracts for a long-range interceptor to North American Aviation, Northrop Aircraft and Lockheed Aircraft Corp. Similar contracts for a fighter-bomber were given to Republic Aviation and North American. Glenn L. Martin and the Douglas Aircraft Corp. will work on a new tactical bomber.

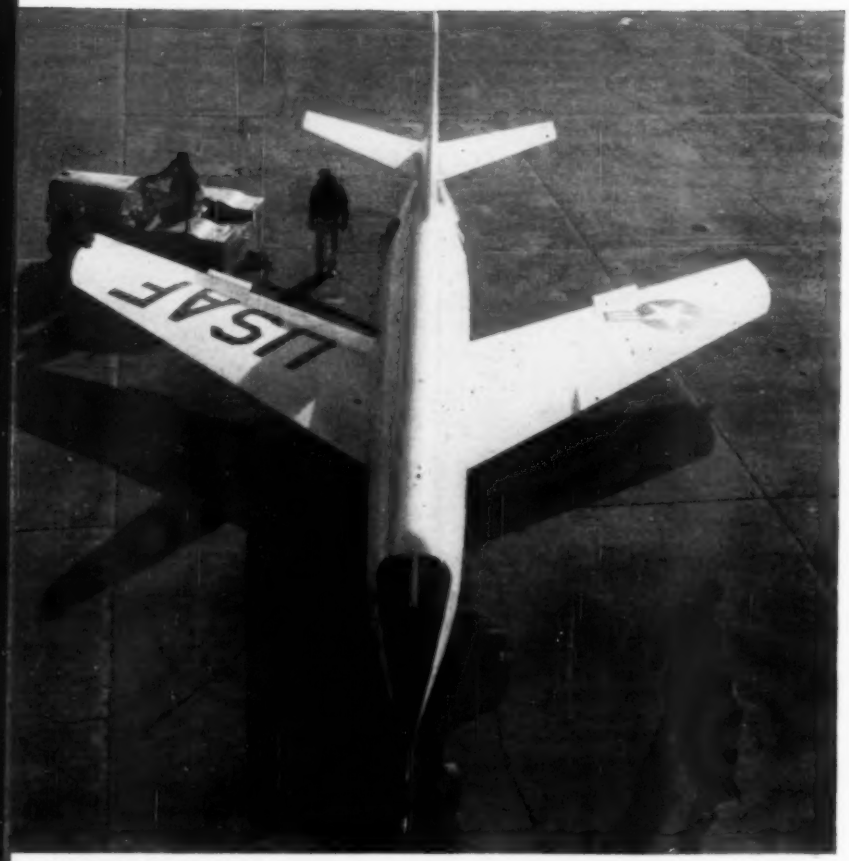
The aim is to reduce sharply the traditional five-to-eight-year development cycle, with corollary heavy savings in engineering manpower and money. No longer will a sizable number of contractors spend millions of dollars producing paper and be left with no development or production contract.

Subcontractors Safe

So far, there have been no loud screams from less fortunate companies who were not tapped for projects. There is concern in the industry that the plan can lead to abuses, that an unfavored company may have a priceless idea that is ignored and that the plan is "a step toward Socialism."

It is important to point out that the elimination of design studies presum-

NORTH AMERICAN F-100s



BELL X-2

ably will have no great effect on USAF subcontractors. If anything, it will make the selling job easier for competent manufacturers. Meanwhile their importance to the Air Force is fully vouchsafed by AMC.

Criticism of prime contractors for invading the realm of their suppliers, manufacturing everything from electronic black boxes to armament and helicopter rotor blades, continues and has brought stern rebukes from AMC and USAF headquarters. Despite this, the trend has not turned in many areas.

At the operational level, USAF's tenderest point again is related to the budget. In the past year lack of funds has been blamed for the virtual grounding of some of Tactical Air Command's fighter planes. Some reports place the

USAF Aircraft on Order

Aircraft Type	Popular Name	Manufacturer
Bombers		
B-47E B-47H	Stratojet	Boeing
B-52B B-52C B-52D	Stratofortress	Boeing
B-57B B-57C RB-57D B-57E	None*	Martin
R-66B RB-66C	None	Douglas
Fighters		
F-84F	Thunderstreak	Republic
RF-84F	Thunderflash	
F-86F	Sabre	North American
F-89D	Scorpion	Northrop
F-89H		
F-100C F-100D	Super Sabre	North American
F-101A	Voodoo	McDonnell
F-102A TF-102A	None	Convair
F-104A	None	Lockheed
F-105B	None	Republic
F-107A	None	North American
Transports		
KC-97G	Stratofreighter	Boeing
C-121C RC-121D	Super Constellation	Lockheed
C-130A	Hercules	Lockheed
C-131D	None	Convair
C-133A	None	Douglas
KC-135A	Stratotanker	Boeing
C-123B	Avitruc	Fairchild
Trainers		
T-33A	Shooting Star	Lockheed
T-34A	Mentor	Beech
T-37A	None	Cessna
L-26D	Aero-Commander	Aero Design
Helicopter		
H-21D	Workhorse	Piasecki

* Canberra is the "popular" name, but not the official name. U. S. has no official name. Canberra is name of the British plane.

REPUBLIC F-84F

percentage as high as one third of the entire force. In the case of the new North American F-100, the correct figure may be as high as 35%.

Skill Problem

Basically, TAC's problem is one of skill. The newer interceptors, such as the F-100, are complicated avionic masterpieces requiring a maintenance effort unheard of only a few years ago. As fast as TAC trains personnel to the necessary degree of skill, there are posts abroad and in the higher-priority Strategic Air Command to which they can be called.

The F-100 is replacing the F-86 in units at home and abroad. A new long-range interceptor must await the outcome of Phase I contracts awarded last August. Meanwhile, USAF is going ahead with plans for a larger version of the McDonnell F-101 Voodoo.

The Strategic Air Command this month celebrates its 10th anniversary. At almost the same time it will start the long process of replacing the formidable Convair B-36 with the B-52 long-range jet bomber. The program will take a long time.

Meanwhile, the Boeing B-47 medium jet bomber has become SAC's most proficient weapon system.

SAC today has 44 wings. Six are heavy bombers, 24 medium bombers and six are fighter wings. The remainder are reconnaissance. There will be 54 wings in SAC by June 30, 1957.

Another critical problem facing USAF is building a new network of air bases designed to meet the geographical and facilities needs of the atomic age. Most USAF bases already in existence were built originally as World War II training fields and do not meet many of the atomic age requirements for operational airfields.

First problem is dispersal. With the bombers of Strategic Air Command as the primary target of any enemy aggression, it is USAF policy to have these bombers as widely dispersed as possible in order to make it extremely difficult if not impossible for an enemy to wipe out this retaliatory striking force.

SAC now has two and sometimes three combat wings on a single airfield. Its goal is to have a single wing dispersed at three separate bases. This will require more new bases. In addition operational bases—whether for SAC or Air Defense Command—must be equipped with underground fuel storage facilities and other protective facilities against atomic attack.

Air Defense Command now has an extremely low operational capability against the new generation of Communist bombers such as the turboprop Bear and the turbojet Bison. ADC now has the single-seater F-86D and two seater Northrop F-89 and Lockheed F-94C as standard all-weather interceptors. All of these fighters lack sufficient altitude capability to cope with the new Soviet bombers. ADC will begin to get the Convair F-102A all-weather fighters this summer. New weapons such as the Hughes Falcon and the Douglas Ding Dong atomic warhead missile will improve ADC's kill capability over its current unguided rocket armament.

TAC Transport

In the transport field, TAC continued to prove its capability on the long haul, mainly with the Douglas C-124 Globemaster. New equipment includes the Fairchild C-123.

Still hotter is the new Lockheed C-130 turboprop transport, on which deliveries have been started. About a month ago the first Douglas C-133A, largest cargo plane ever put into production, was rolled out of the factory. The C-130 is powered by four Allison T56 turbines and the C-133A by four Pratt & Whitney T34-P-3 turbines. The Douglas plane will carry a payload of 50 tons.

Force Levels

The following military airpower force levels are scheduled to be reached by the end of Fiscal 1957:

USAF—137 wings including 126 combat wings plus 11 troop carrier wings.

NAVY—17 carrier air groups
31 anti-submarine squadrons
3 Marine air wings

ARMY—2,954 aircraft

U. S. Plane Inventory

(End of fiscal year)

	1956	1957
USAF	26,429	26,736
NAVY	12,548	12,576
ARMY	3,534	3,954
TOTAL	42,511	43,266

BOEING YC-97Js WITH P&W T-34 ENGINES

DOUGLAS A4D-1

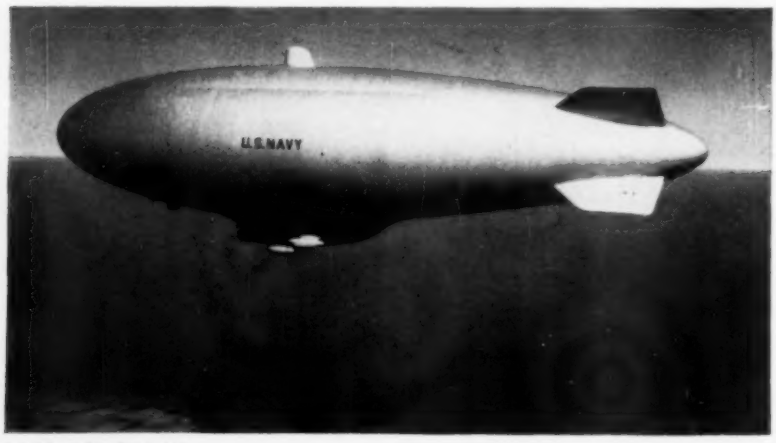
Navy's 1956 Hopes: End of Frustration,

By Cecil Brownlow

Within the circle of debate—and often fear—over the relative merits of U. S. and Soviet airpower, the U. S. Navy presents a picture of almost startling, and desperately needed, improvement. After a frustrating era of funds' restrictions and the resultant technical starvation, 1956 should be a bumper year—one in which the Navy will receive aircraft and missiles that are good enough, carriers that are sturdy enough, for it to carry out its assigned role as a "big stick" in the age of atomic deadlock.

Until now, and even before the knowledge of Russia's technological breakthroughs (AW May 23, p. 12), the Navy's "stick" has been relatively hollow; the power of retaliation was there, but the question of its effectiveness was something else again. The most glaring example of weakness came during the Korean war, where the Navy was forced to fight its battles with World War II "hand-me-downs."

The war did serve, however, to reopen the research-and-development funds spigot.



GOODYEAR ZPG-2W

The Tide Turning

The results are now coming off the line, and the Navy feels that its crop of new jet aircraft and new or modified carriers will give it the strength needed to deliver atomic retaliation from widely dispersed, relatively secure task forces and/or by long-range jet bombers.

"Things look good," one Navy official said recently, "but they were looking awfully bad before they looked good." The new planes, which will finally take the propeller from the Navy's front-line aircraft, include:

- **Chance Vought Aircraft's F8U Crusader,** a 1,000-mph.-plus fighter with great promise. Now entering the production stage, the Pratt & Whitney J57-powered Crusader is expected to become operational sometime next year.
- **Douglas A3D Skywarrior** 600-mph. attack plane. Powered by twin P&W J57 turbojet engines, the A3D is currently being introduced into the fleet as a replacement for North American's propeller-driven AJ-2 Savage.
- **Douglas A4D Skyhawk.** Smallest and lightest U. S. jet combat plane but with the capability of carrying nuclear weapons, the Skyhawk will begin fleet evalu-

LOCKHEED WV-2

Better Air Arm

ation trials this month. Bureau of Aeronautics' Aircraft Division planners expect it to reach the fleet before the year's end. Powerplant is a Curtiss-Wright J65.

• **North American FJ-4 Fury.** An improved version of the FJ-3, the FJ-4 will go into the fleet within the next few months. It is powered by an advanced Wright J65.

• **Douglas F4D Skyray.** Hampered in its early stages by engine difficulties and development delays, the J57-powered F4D will soon enter the fleet.

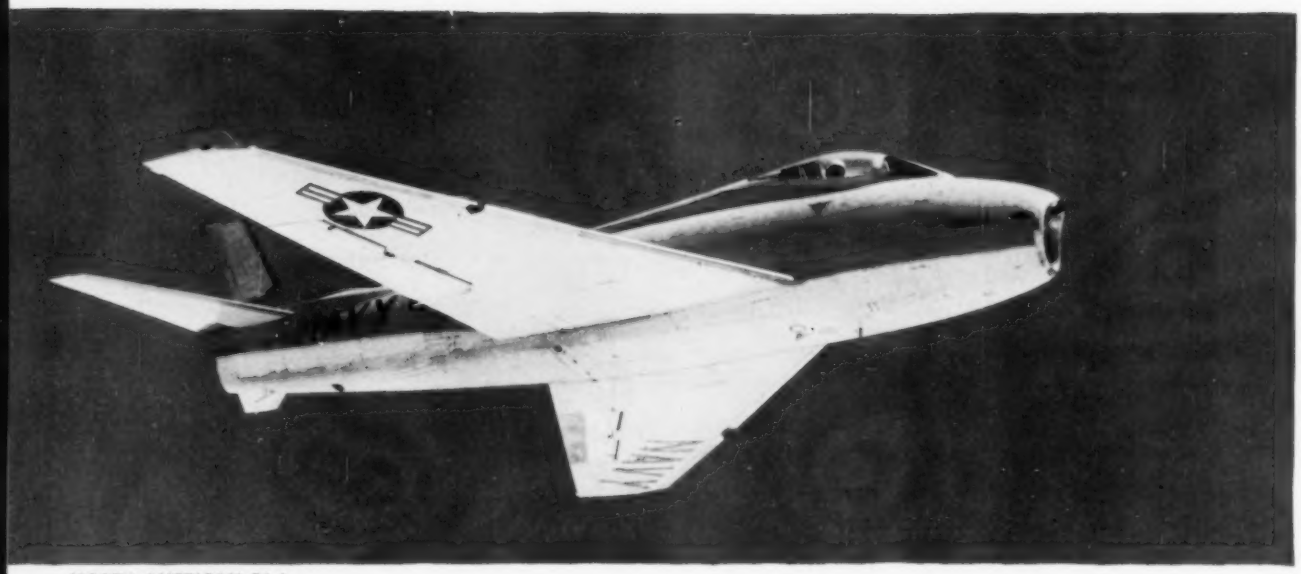
• **Martin P6M** long-range jet bomber. Despite the crash of the SeaMaster prototype, the Navy has high hopes for this long-range bomber which, with the aid of tanker submarines or ships, could operate effectively against almost any target within the Sino-Soviet orbit. A modified version of the P6M is being considered as a test bed in Navy experiments on nuclear-powered aircraft engines. Power for the prototypes is supplied by four Allison J71s but production versions will carry P&W J75s.

• **McDonnell F3H-2N.** Younger, more powerful brother of the ill-fated F3H-1, the F3H-2N is powered by a 10,000-lb.-thrust J71. The F3H-1 carried a 7,200-lb.-thrust Westinghouse J40.

• **Convair R3Y-2 Tradewind** turboprop tanker-transport. Powered by four Allison T40 engines that turn contra-rotating propellers, the 82-ton, bow-loading

McDONNELL F3H-2N

DOUGLAS A3D-1



NORTH AMERICAN FJ-4

Tradewind can attain speeds of almost 400 mph. Convair has completed its contract for 11 of the transports, and deliveries will begin this spring.

Grumman's F11F-1, the Navy's first area-ruled fighter and one plagued with engine difficulties in its early days, is still in the development stage. It will reach the fleet next year, along with Grumman's F9F-8T, trainer version of the F9F.

'Buddy System'

Another technique scheduled to reach the fleet this year, and one that in some respects is almost as important to the Navy as its new aircraft, is the inflight-refueling "buddy system" that will allow smaller attack aircraft with 700-1,000-mile ranges to hit far inland from task forces well at sea.

Under this plan, a 36-plane group will be split into 18 tankers and 18 combat aircraft for long-range missions. On shorter missions, the tankers will revert to combat status.

A4D-2s, the first planes to be equipped to handle the "buddy system," should reach the fleet sometime late this year.

Nuclear-Power Transition

In addition to the substantial progress of its aircraft striking and protective force, the Navy this year will seriously begin the transition of its sea forces from oil to nuclear power.

With the value of a nuclear powerplant confirmed by the Nautilus, the Navy's Fiscal 1957 budget requests include funds for the construction of an $88-million nuclear cruiser (it will be the first surface ship with nuclear power), for another six nuclear-powered submarines and for a nuclear plant to power a carrier of the Forrestal class. Funds for the carrier itself will be requested in the 1958 budget.

Missile Progress

In another, but related, effort, the Navy is managing to stock a fairly formidable array of missiles, both defensive and offensive.

They include:

- **Sperry Sparrow** air-to-air missile now in quantity production.
- **Convair Terrier,** a proven veteran that provides the principal armament for the Boston, the Navy's first guided-missile cruiser.
- **Chance Vought Regulus.** Powered by an Allison J33 turbojet engine, the Regulus can operate from shore, shipboard and submarine deck.
- **Philco's Sidewinder** air-to-air missile is now in the development production stage.
- **Talos.** Sponsored by the Navy's Bureau of Ordnance and still in the experimental stage, the anti-aircraft Talos integrates the Terrier airframe and a ramjet engine.

In addition to its regular, day-by-day missile research programs, the Navy is sponsoring a top-priority project to develop means of launching intercontinental ballistic missiles (when they arrive) from battleships and similar vessels. Rear Adm. William F. Raborn commands the project.

The task of keeping the Navy's air arm as a whole from falling to another Korean low rests largely with the Bureau of Aeronautics, whose tight, efficient planning contributed to the development of the present flow of aircraft and missiles.

Headed by Rear Adm. James S. Russell and with much of its research and development in the hands of Rear Adm. William Schoech, the bureau recently reorganized and pruned itself in an effort to further trim the development cycle and to improve procurement practices.

In dealing with the complexity of modern weapon systems, Adm. Russell wants a "high birth rate" for new ideas and prototypes coupled with a "high rate of infanticide."

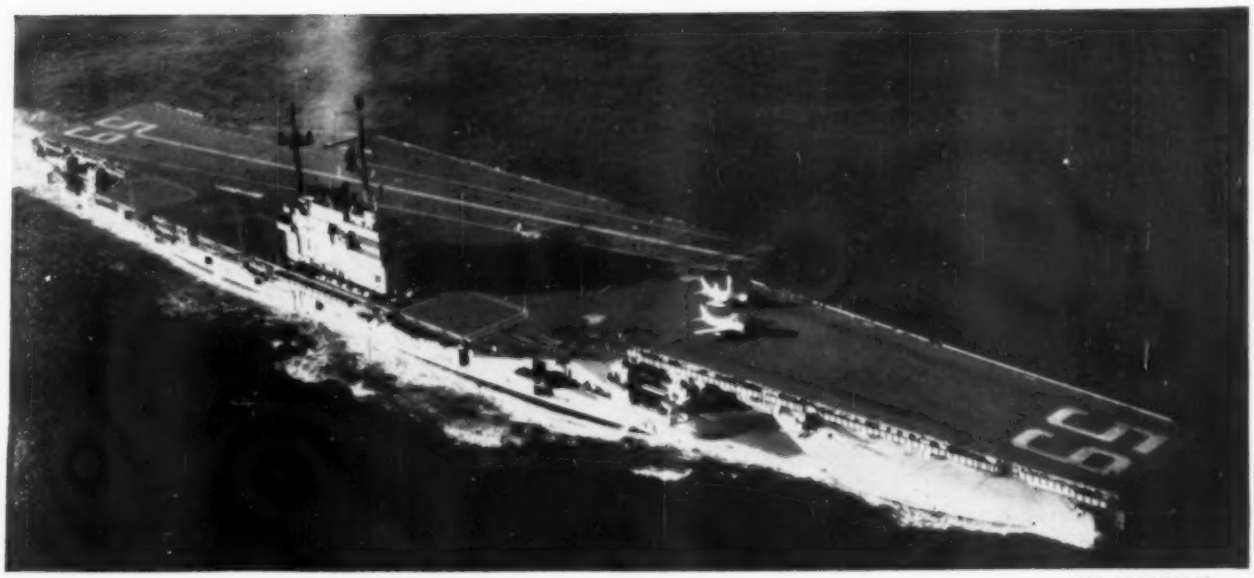
Firm Plan

As one means of accomplishing this, BuAer has adopted the FIRM (Fleet Introduction of Replacement Models) Plan—similar to USAF's Cook-Craigie Plan—which provides for cautious, relatively slow production in the initial stages and then for a sudden upsweep in the curve once the bugs have been found and the fixes incorporated into the production line. This, the bureau feels, saves not only time and money but lessens the chances of a recurrence of the politically embarrassing, highly publicized F3H-1 incident in which $65 million was expended for a virtually nonflying fighter.

For the moment at least, the bureau's

Navy Planes on Hand

(End of fiscal year)	
1953	13,308
1954	13,073
1955	12,821
1956	12,548



USS FORRESTAL

most pressing problem lies in the field of avionics. "The human eye," as Adm. Schoech explains, "was made for 150-knot flying."

To achieve acceptable combat performance with 1,000-mph. aircraft such as the F8U, both the Navy and the USAF need surer avionic means of detecting the enemy, tracking him down and intercepting him.

The Navy has the added avionic problem (an old one) of finding ways and means of getting its aircraft safely back to the carriers after they have gone beyond Tacan range. The bureau's Electronics Division is now exploring the infra-red field for an answer.

In another effort to move on into higher, faster flight, the Navy this year tripled its request for research and development facilities—from $10 million to $30 million. A large portion of the increase will go towards the construction of research facilities to explore the "thermal thicket."

Methods and Materials

Other major projects before the bureau include:

- **Ramjet and rocket** research for piloted aircraft.
- **Jet noise** and what to do about it.
- **Vertical-takeoff aircraft** developments. During the past year, Convair's XFY completed the transition from vertical to horizontal flight, substantially increasing the state of the art.
- **Human-factors equipment,** from better helmets to ejection systems.
- **Anti-submarine warfare** weapons and detection systems.
- **Titanium alloy development.** The bureau is looking for a titanium alloy that can be manufactured in quantity, rolled in sheets and retain its strength for use as an on-the-shelf item in order to spur designers into using more titanium.
- **Better aircraft metals.** "Fatigue," one official explained, "now determines the life of an aircraft."
- **Search for a small jet aircraft** to be used as a primary trainer.
- **Better hydraulic fluids** and the equipment that goes with it.

Enter Angled Deck

So far as accomplishments over the last 12 months are concerned, a number of top-drawer officials consider the angled carrier deck as the "big breakthrough" in carrier aviation for 1955.

Through new construction (the Forrestal) and conversions, the Navy is operating seven angled-deck carriers. Four additional Forrestal-type carriers have been authorized, and the Navy is asking for money to build a fifth. (Navy planners say they would need a minimum of from 10 to 12 in the event of all-out war.

Probably the best feature of the angled deck is its ability in wartime emergencies to receive returning fuel-low attack planes and to simultaneously launch defending fighters.

Coupled with the new steam cata-

Navy Aircraft on Order—1956

COMPANY	PLANE	NAME
	FIGHTERS	
Douglas	F4D	Skyray
Grumman	F9F-8	Cougar
	F11F-1	Tiger
McDonnell	F3H-2	Demon
North American	FJ-3, -4	Fury
Chance Vought	F7U-3	Cutlass
	F8U-1	Crusader
	PATROL	
Martin	P5M-2	Marlin
	P6M-1	SeaMaster
Lockheed	P2V-7	Neptune
	WV-2	Constellation
Grumman	S2F	Sentinel
	HELICOPTERS	
Bell	HSL-1	
	HTL-6	
Kaman	HOK	
Sikorsky	HSS-1	
	HR2S	

COMPANY	PLANE	NAME
	BLIMPS	
	ZPG-1, 2, 2W, 3	
	ZSG-2, 3	
	XZSG4/ZSG4	
	XZS2G-1/ZS2G-1	
	ATTACK	
Douglas	AD-5, -6, -7	Skyraider
	A3D	Skywarrior
	A4D	Skyhawk
	TRANSPORTS	
Douglas	R6D	Liftmaster
Lockheed	R7V-2	Constellation
Convair	R3Y-1	Tradewind
	R4Y	(no name)
Cessna	OE-1, -2	(no name)
	TRAINERS	
Lockheed	TV-2	Shooting Star
North American	T-28	(no name)
Beech	T-34	Mentor

pult and the Mark 7 Constant Runout Arresting Gear, the angled deck also lessens the carrier's traditional dependence upon the wind.

Mirror Landings

Another major step forward in the realm of carrier operations should be forthcoming with the full development of the British-devised Mirror Landing Device. Already installed aboard the Bennington on an experimental basis, the mirror-and-lights system is designed to bring aircraft onto the deck with greater accuracy and safety than a landing signal officer could possibly manage.

The Bureau of Aeronautics plans to install the system at naval air stations as rapidly as possible. Their introduction into the fleet, however, will have to await further evaluation.

Other developments over the last twelve months:

• **Goodyear Aircraft's ZPG-2W airship** reached the operational stage. Designed for anti-submarine, early-warning duty, the 2W version of the ZPG is equipped with improved avionic searching devices and a radome bubble mounted on top of the envelope.

• **Sikorsky HSS helicopter,** equipped with sonar and other anti-submarine devices, reached the fleet.

• **Chance Vought F7U** Cutlass took its place in the fleet seven years after the development of the first prototype.

• **Larger rotor** was mounted on the Sikorsky HR2S helicopter to increase its load capability and improve its landing and flight characteristics.

• **Supersonic bomb release** was developed by the Bureau of Aeronautics' Armament Division. A small, lightweight device, the instrument earlier this year made it possible for a Navy plane to make a bomb drop while flying at Mach 1.2, the fastest speed ever recorded for such a release.

Most of the weapons the Navy has received, or will receive within the coming year, are pointed outward—offensively—but one of its greatest worries is turned inward, towards defense.

Navy officials look upon Russia's emphasis on submarine production as backhanded confirmation of their own thesis that a strong Navy is vital in any war, regardless of the availability and ability of land-based aircraft and missiles. This, unfortunately, does nothing to lessen the potential danger.

The Navy feels that its dispersed, mobile task forces spread over a 30,000 sq.-mi. area will provide poor targets for any type missiles and that its own missiles, advanced radar-warning system and fighter aircraft will provide relative immunity from enemy planes.

Submarines are a different matter. At latest count, the Soviet navy had something over 400 (the Germans started World War II with 57) and the capability of producing another 100 a year.

Researcher's Goal

The goal of the researcher and operations' man alike is to create the electronic means and the proper platforms to find the submarine before it can make its kill and, at the same time, to have the proper weapons on hand to make the counter-kill.

The emphasis the Navy feels it must place on its own defense is underscored by its Fiscal 1957 budget requests which show that, while naval air strength will remain at its present level of 17 aircarrier groups, the number of anti-submarine squadrons will be increased from the present 19 to 31 by June 30, 1957.

The new destroyers, frigates and cruisers called for in the budget also will be equipped with underwater missiles, some with nuclear warheads.

Aircraftwise, the Navy's anti-submarine defense is in capable hands. It employs five principal types of anti-submarine platforms, all of them crammed with as much detection gear as possible and/or available: land-based planes such as the P2V-7; carrier-based, fixed-wing aircraft (Grumman's S2F); helicopters (the HSS-1 is the present mainstay); lighter-than-air, and seaplanes (the Martin P5M-2, last of the Navy's piston-engine flying boats).

In still another field, the Navy hopes to receive a report within the near future from a Princeton University research group that has been working quietly for the last three years on engine damage resulting from combustion oscillation. The report will, the Navy hopes, provide the basis for engine designs free of pressure oscillation.

The Navy this year also will expand its automatic telemetering weather system, including expanded use of weather buoys, balloons and the "grasshopper" telemetering instruments that can be dropped in remote areas from aircraft. Production of the "grasshoppers," now handled by Naval Ordnance, will be handed out to industry on a competitive basis within the near future.

Moving in other directions and struggling hard to keep its development "right up against the envelope of the state of the art," the Navy also has these plans for 1956:

• **Integrated crash helmet** officially designated the H-5 and developed by the Mine Safety Appliance Co., of Pittsburgh, will be introduced to the fleet. The helmet, which has remained on dummy heads in sled-test ejections at 600 knots, is designed to provide improved crash protection and sound attenuation.

• **Full pressure suit** will be introduced as standard equipment with all supersonic planes. The suit allows almost complete mobility and has successfully passed chamber tests at altitudes up to 100,000 ft.

• **Liquid oxygen** will be introduced as standard equipment on all new high-performance aircraft because of the need for large amounts of oxygen and its weight and space-saving potential.

GRUMMAN S2F LANDS ON USS LEXINGTON

Army Aviation Set to Hurdle Size Limits

By Evert Clark

The U.S. Army has under way a six-year program for expansion of its "organic" aviation. It is putting strong new emphasis on educating the public—and Congress—to Army Aviation's functions and needs. It is taking a new look at research and development in such vital fields as vertical and short takeoff aircraft.

But the most significant advance for Army Aviation in 1956 may well come in the field of policy.

There are many indications that the Army this year may try to break away from dependence on the U.S. Air Force for some of the missions which it feels belong to the Army.

Right now the Army is bound by the 1952 Memorandum of Understanding, in which the Secretaries of the Army and Air Force agreed that the Army would operate fixed-wing aircraft of no more than 5,000-lb. empty weight.

But some key Army officers—especially research and development men, who must come up with tomorrow's airplanes—feel the memorandum is hampering Army Aviation greatly by imposing an artificial limit of size rather than the realistic one of mission.

"The memo is getting to be a phobia in some quarters," one Pentagon officer told AVIATION WEEK. "A memo written more than three years ago does not reflect today's state of the art nor the state of the art three years from now.

"The trouble is the Army is trying to play the real gentleman. Need will have to overrule the gentlemanly approach. The memo is putting a tremendous damper on research and development into planes of the size we need to accomplish the tasks assigned to us."

Caution on the part of Army leaders results primarily from fear that they will be criticized for trying to take over a part of the Air Force's role or form an "Army Air Corps."

No Threat to USAF

The Army's leaders, and even officers critical of the Memorandum, repeatedly emphasize that they want only what they need to fulfill Army missions.

Army Chief of Staff Gen. Maxwell D. Taylor said last month that "at the present time, I am still looking to the Air Force to provide close air support, and I am not seeking my own Air Force by any manner or means."

He pointed out that logistical mobility—"internal transportation necessary to move our men, our supplies and our equipment on the battlefield"—is "not in competition with the Air Force."

Gen. Taylor made it clear that he is not satisfied with the amount of long-range, or strategic, airlift which the Air Force can supply to the Army. By June 30 the Air Force will have only 11 troop-carrying wings instead of the 13 it has now or the 17 called for in the old 143-wing plan.

Gen. Taylor said he realizes that it is a "question of competing requirements" between combat and transport planes, and he recognized that "the Air Force has a serious problem of meeting its budgets and its needs."

But he gave no indication that the Army cares to move into the strategic airlift field.

The Army obviously feels limited, however, in two important sectors of the logistical mobility field because of its agreement with USAF:

• **Fixed-wing troop-lift aircraft.** The de Havilland U-1, coming into company use this year, carries only 10 men with full equipment. It is the largest the Army has. (The largest helicopter in operational use carries up to 15 men, depending on the equipment they must take with them.)

• **"Aerial fighting vehicles."** These are the Army's aircraft of the future, which Brig. Gen. Carl I. Hutton, commander of the Army Aviation Center at Ft. Rucker, Ala., has challenged industry to produce to meet the "urgent need for increased mobility" (AW, Dec. 26, 1955, p. 15).

Gen. Hutton wants armored aerial

CESSNA T-37

MCDONNELL XV-1

Army Jets?

Department of Defense has ordered the Air Force to loan Cessna T-37 jet trainers to the Army "in quantity" for evaluation tests. Army first ordered 10 of its own but USAF objected. If Army were to use T-37s, they would be Army Aviation's first jets. Army's interest is in observation and reconnaissance use, rather than for training purposes.

Army Types on Order

Army currently is purchasing the following fixed- and rotary-wing aircraft:

Company	Designation	Type
Cessna	L-19	Observation
De Havilland	L-20	Utility
Beech	L-23	Command
Aero Commander	L-26	Command
De Havilland	U-1	Cargo
Bell	H-13	Reconnaissance
Sikorsky	H-19	Utility
Piasecki	H-21	Cargo
Hiller	H-23	Reconnaissance
Piasecki	H-25	Reconnaissance
Sikorsky	H-34	Cargo
Sikorsky	H-37	Cargo
Bell	XH-40	Utility
Hiller	X	Reconnaissance
DeLackner	X	Reconnaissance

Note: The twin-engine Sikorsky H-37 will be the Army's first medium (3 ton) cargo helicopter, but it is not yet in the hands of troops. The H-16B still is in the development stage. A mockup of the XH-40 has been approved and work on a prototype is getting underway but delivery still is in the future. Army has ordered 12 DeLackner one-man helicopters and expects delivery early in Fiscal 1957. Delivery of the 12 Hiller one-man "Flying Platforms" on order will come sometime later.

SIKORSKY H-34

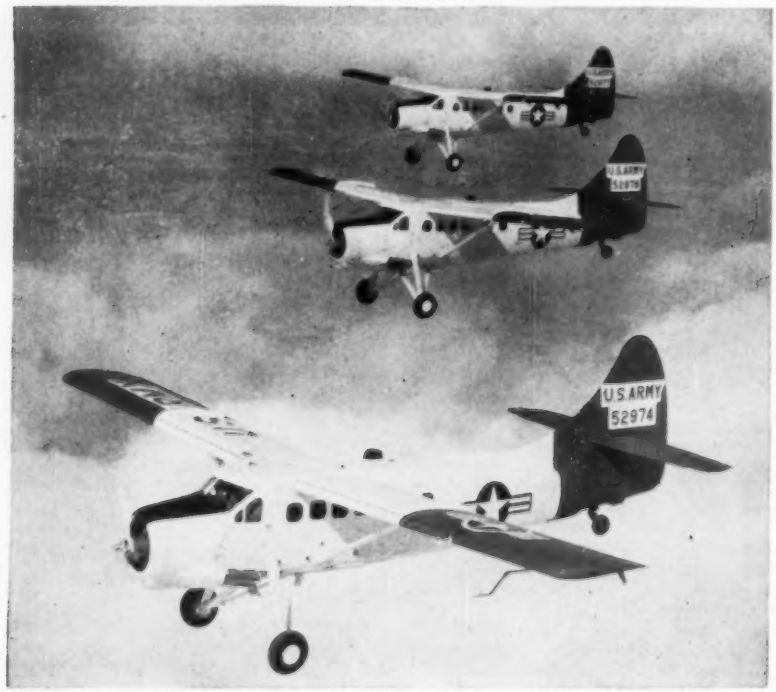
vehicles which will "find, fix and finish" the enemy. The finding vehicle, of course, would be a reconnaissance plane, but much faster than the present L-19. Gen. Hutton says it would not duplicate USAF reconnaissance equipment for long-range missions.

The fixing vehicle would hold an enemy in position, as artillery does, and in some cases it would, like artillery, make the kill.

The destroying vehicle would be a heavy fighting unit, comparable to a tank in armor and firepower.

Gen. Hutton said the Memorandum deprives the Army of the freedom it needs to sponsor development of these "aerial fighting vehicles."

He said the 5,000-lb. limit must go and the Memorandum be entirely rewritten to let Army mobility and firepower catch up with the demands of its mission.



DEHAVILLAND U-1S

Close Support

Although he leaves the role of interdiction to the Air Force, he insists that close support "is an integral function of the ground battle, and it must be completely responsive to the will of the commander."

It could be pointed out here that Gen. Taylor, in speaking of close support, said he was "still looking to the Air Force" to provide it "at the present time."

The Army also is looking more and more to the Marine Corps and the Navy as it considers its needs for close support. Marine Corps thinking on the use of close air support is nearer to the Army's viewpoint—that close-support must be under the direct command of the ground unit.

If the 1952 Memorandum is not scrapped or changed, some of its limitations may be circumvented anyway.

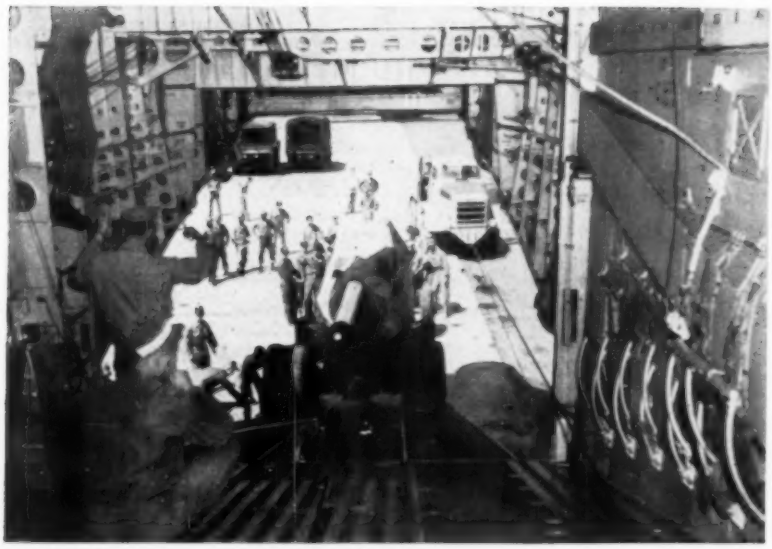
The Army has shown considerable interest in the Navy's Convair R3Y transport and the Martin P6M SeaMaster. It has made joint tests, using the R3Y for paratroop drops.

Congressional hearings on the Fiscal 1957 budget may provide the forum for real debate on the limitations on Army Aviation.

Army Aviation Expands

Meanwhile, Army Aviation is going ahead in these areas:

• **Gen. Taylor told** a national television audience recently: "We have a six-year program ahead of us which I think is vital to the future of the Army. It's the continued development of a program



ARMY LOADS 155mm. HOWITZER ON C-124

which has been in existence for some time. It's to give us the low performance aircraft, aircraft with a short runway capability that can be right with our troops to give us observation from the air, for our artillery, for our missiles, to move small bodies of troops, on reconnaissance, and that kind of thing, to move our supplies over rivers and mountains, if necessary." He said the program calls for "four or five thousand aircraft." The Army expects to have more than 3,900 aircraft this year. It will spend $110 million for aircraft this year ($8 million less than last year), but has asked no new obligatory authority.

• **At the first of the year** the Army had 12 Army Transport Helicopter companies of 21 cargo helicopters and 2 reconnaissance helicopters each.

• **One Fixed Wing Tactical Transport** Company has been activated, with 21 U-1 cargo planes, on which it expects delivery by June 30. The U-1, built by de Havilland of Canada, carries up to 2,000 pounds of cargo or 10 fully equipped troops.

• **Early this year,** the Army began a program at Spence Air Base, Moultrie, Ga., which will give basic training to 600 Army aviators a year. This phase of flight training is being conducted by and/or under the direction and supervision of USAF. Ten weeks of advanced tactical flight training follows at Ft. Rucker. The Army has approximately 3,500 aviators on active duty, including 500 cargo helicopter pilots.

Included in the Army's six-year program for building up its "organic" aviation are plans to use the Piasecki H-16B, its first heavy (5 ton) cargo helicopter. The Army notes that one is "being constructed based on engineering data made available with the completion and flight testing of the YH-16-A," which crashed early this year. Delivery of this helicopter is not expected for several years.

The six-year plan also includes the Bell H-40, which will replace the Sikorsky H-19 utility helicopter, now used to transport supplies, equipment, personnel, small units, and for evacuation of wounded. The H-19 carries a pilot, copilot and seven passengers or six litter patients, or approximately 1,800 pounds of cargo. The H-40 will carry more than 800 pounds.

In the helicopter field, research and development work will emphasize turbine engines, instrumentation, and basic research on boundary-layer control. Cessna is now flying a helicopter using boundary-layer control on its rotors.

Other major Army R & D interests:

• **Turbine engines** for convertible-type planes.

• **Basic research** on boundary-layer control with the emphasis on the optimum approach, followed by an aircraft embodying this approach, rather than more boundary-layer work aimed simply at modifying existing aircraft. The biggest goal is to get lower landing speeds.

• **The whole field** of vertical takeoff and landing (VTOL) and short takeoff and landing (STOL) aircraft.

Army Planes on Hand

(End of fiscal year)	
1953	3,200
1954	3,633
1955	3,539
1956	3,534

● NATO

NATO Nations Wary of Nuclear Weapons

PARIS—During 1955 the air forces of the North Atlantic Treaty Organization in Europe edged away from the question of buildup, size, training and efficiency. With progress reasonably satisfactory on these familiar problems, another problem—even more critical—is overtaking the NATO organization, in the air and on the ground: In an age of increasing employment and of dependence on nuclear weapons capable of being delivered from greater distances, what is the real future for a "classical" defensive air arm operating with relatively small ground forces in the small geographical area of Western Europe?

Does such a force deter, or help to deter, the Soviet Union from aggression? More important, if not equipped with nuclear weapons, will it in fact contribute to deterrence in the years ahead?

Military men in Europe pondered these questions but recognized them as being mainly political and outside their scope of direct control. They advise and hope that political leadership ultimately will provide the right answers. In the meantime, they take some pride in the forces in hand.

Command Tightened

In 1955 the air arm of the North Atlantic Treaty Organization forces in Europe reached a new high in power and readiness. With approximately 6,500 aircraft somewhat more closely under his command in the long arc from Norway to Turkey, General Alfred M. Gruenther, Supreme Commander Allied Powers Europe, could expect to knock down a high proportion of attacking planes of the types likely to be used at present in the event of war.

This was demonstrated in a series of tests and maneuvers held during the last year throughout the NATO area. With an improved radar and unjammable communications network underway and further modernization of operating aircraft, 1956 and 1957 will see a further improvement in effectiveness of West Europe's air defenses.

The addition of some 1,300 aircraft in Germany's revived Luftwaffe in 1959 and 1960, will bring NATO air forces to peak numerical strength.

Quality Fighters

NATO's airfield program, which called for 165 fields in Great Britain and the 11 continental countries in the pact, is virtually completed. Dispersal is considered satisfactory, but many of the fields require additional facilities for proper operation.

Numbers of aircraft increased only slightly during 1955, but quality showed steady improvement. Additional F-86s, F-84Fs, French Mysteres and British Hunters went into service, permitting retirement of older aircraft in almost all of the national air forces in Europe. The first F-100s are reaching Europe this spring.

NATO's Ministerial Council in December considerably strengthened the command organization of NATO airpower. During the first five years of NATO existence control over air forces remained with national governments, with the Supreme Commander and his deputy for air exerting only limited and indirect control. Under the new system national air forces will move part way toward a unified command arrangement by developing a system of four regional headquarters (North, Central and South Europe and the British Isles).

Unjammable Communications

The same NATO Council meeting also approved a new communications system, replacing the current system, which depends on a combination of shortwave, VHF and civil cable systems. The new integrated system will employ ionospheric and tropospheric forward-scatter signaling, recently developed in the United States and said to be virtually impossible to jam. Ultimately the European network will be linked with the North American early-warning system.

General Gruenther recently stated that NATO forces could be counted upon to check, though probably not to stop, an all-out attack from the East. He laid down two requirements to bring West Europe's defenses up to their needed level:

- **Germany's** contribution both on the land and in the air.
- **The ability** to employ nuclear weapons.

German Plans

Barring a major change in Soviet policy which would permit peaceable reunification of Germany (and would almost automatically nullify Germany's participation in NATO), it would appear that German military strength will definitely be added to NATO power during the next five years. Plans for the training of a German air force are well under way. Messerschmitt has arranged to produce the Fouga Magister jet trainer in Germany. Other licensing arrangements are being negotiated to permit a rapid rebuilding of the German aircraft industry. German technical personnel are being trained abroad.

The air arm of Germany's new armed forces, according to present plans, will consist of 6 large groups of slightly more than 200 aircraft each, for a total of 1,300 planes. These groups—interceptor and ground support—will be developed gradually, with the first to be in operational service by 1958. As they come into being, American and British units currently stationed in Germany will redeploy.

Atomic Weapons

Use of atomic weapons by NATO forces received a formal blessing by the Council of Ministers at the end of 1954.

At that time a considerable amount of public criticism of the decision developed in several member countries. The only known atomic weapons in the hands of forces under NATO command are a few American Army units in Germany equipped with artillery and missiles designed to take atomic warheads. Units of the Strategic Air Command stationed in areas peripheral to the NATO command, but under direct United States command, presumably are equipped with nuclear weapons.

The political battle in Europe over the use of nuclear weapons is far from over. Its outcome will have a direct impact on NATO's existence and particularly on the future of European air forces.

Europe's Question

Essentially, the question for European members of NATO is this: Even if NATO military forces in Europe, including the tactical air forces, have contributed to the deterrent during the past five years, will such forces help to deter the Soviet Union when that nation has a full range of nuclear weapons and an ability to deliver them anywhere in the world?

There is a growing belief in Europe that the true deterrent has been, and will continue to be, the strategic power of nuclear weapons as employed by the United States (and possibly later by Great Britain). If this belief receives some confirmation during the coming years, the meaning of NATO

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military forces, however armed, will be clouded with doubt.

Many Europeans reason this way:

If the Soviet-United States race for superiority in nuclear weapons ends in a deadlock, with neither side able to use effectively the threat of force as an implement of national policy, NATO forces in Europe will be useful to the extent that a "lesser war" is possible—a war in which either the U.S. and USSR would not be directly involved, or one in which neither could or would use its "ultimate weapons." In such a war, an effective line of demarcation between "tactical" and "strategic" nuclear weapons must be sought and virtually agreed upon by both allies and enemies of Western Europe. If such a line cannot be drawn, the arming of the West's forward forces in Europe with nuclear weapons would make any outbreak of war merely the first stage of a general war.

Political Difficulties

This trend of thought is sufficiently strong that it is possible to predict at least this: If the United States agrees to provide its continental European allies with nuclear weapons, most will find such an offer politically difficult, perhaps impossible, to accept.

In mid-January, leading European politicians—both conservative and socialist—convened in Paris under the leadership of Jean Monnet to discuss the future of nuclear energy in Europe. These men, representing France, Italy, West Germany and the three Benelux countries, reached an easy and unanimous decision that *all* of Western Europe's efforts in the field of nuclear development should be devoted to peaceful uses.

This tendency, based on the belief that nuclear weapons in the hands of the European members of NATO have little or no effective meaning for the maintenance of peace, is important as far as NATO and Western European air forces are concerned. The value of such forces (and land forces as well) unequipped with nuclear weapons against an enemy able to employ such weapons will obviously be modest—so modest that the maintenance of such forces probably will not be thought to justify their costs.

Thus, the major upcoming problem for NATO air forces lies in the political realm—the politics of deterrence and of Europe's part in it. Today it is a good defensive force, capable of putting up a good fight of the sort which would probably take place if war were to break out this year. Without a political solution to the problem of the next stage of its evolution, NATO's airpower in Europe will become progressively obsolete.

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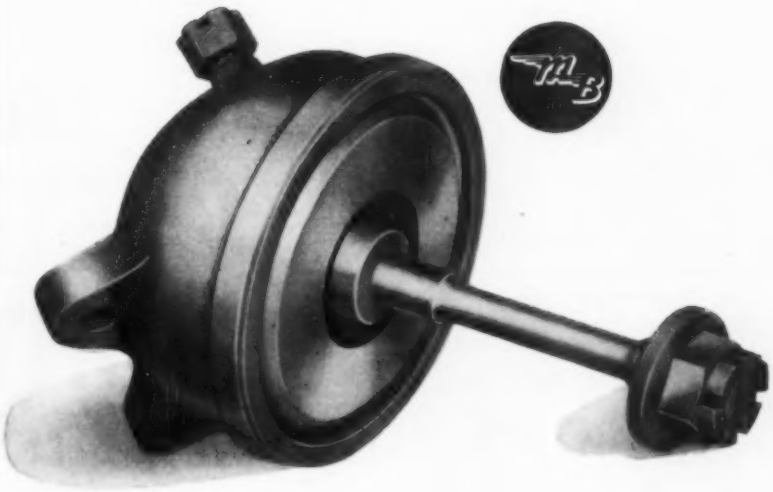

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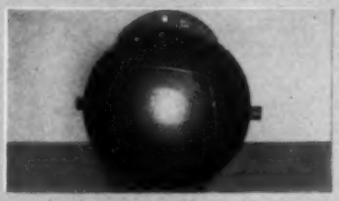

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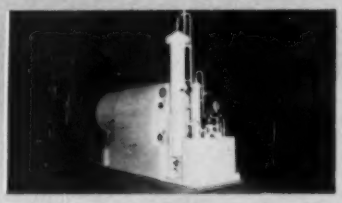
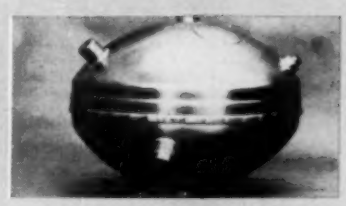
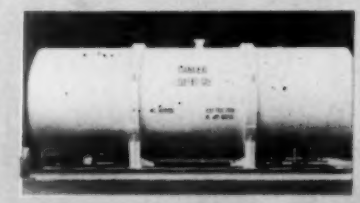


Helium Purifier



5 Liter Liquid Oxygen Container



2160 Gallon Liquid Oxygen Container

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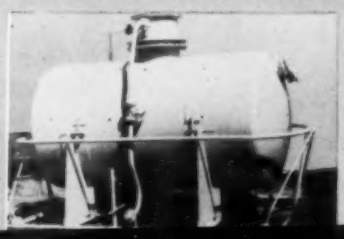

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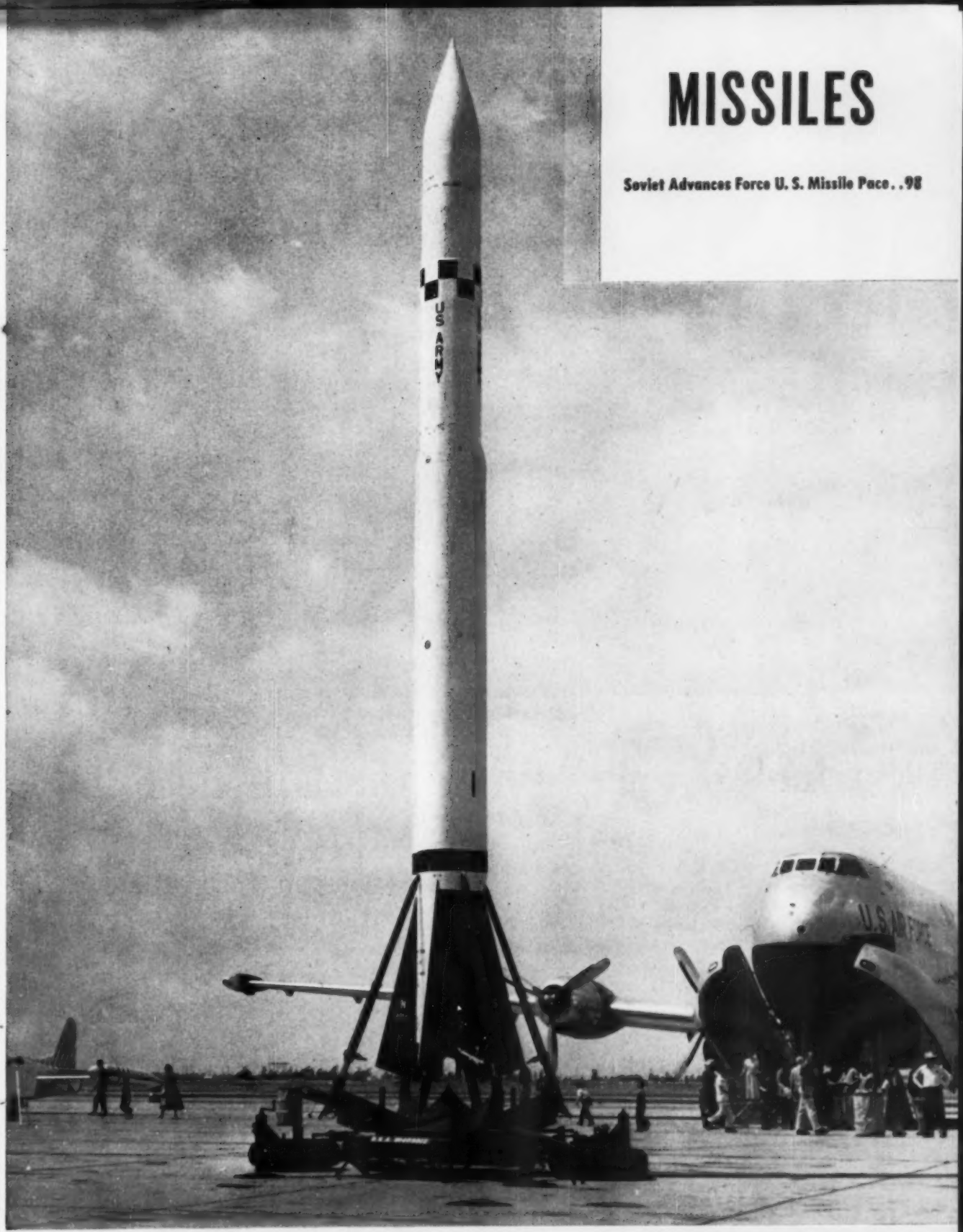
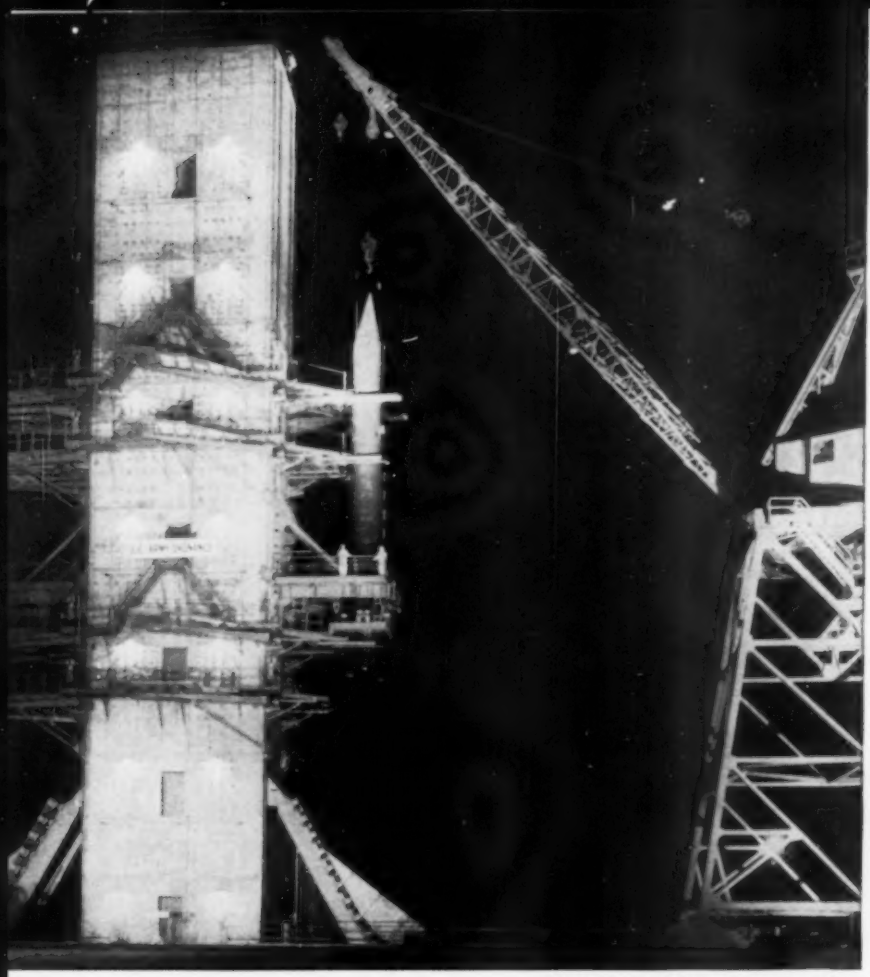
Soviet Advances Force U. S. Missile Pace..98





ARMY'S REDSTONE IN TEST STAND

REDSTONE IN FLIGHT

Soviet Advances Force U.S. Missile Pace

By David A. Anderton

The course of the U.S. missile program has been altered abruptly.

The Russians did it by test-firing a 900-mi. range ballistic missile with some form of guidance. They did it not once, but enough times during the past six months to indicate that the missile is in the developmental test phase.

Highest-level military and Administration acceptance of these Russian successes with the intermediate range ballistic missile (IRBM) has lead to drastic and basic revisions in the guided missile program.

These revisions take two forms:

• **Creating a top-level position** to oversee the complexities of missile management for the services.

• **Diluting the already-thinned engineering economy** by adding back-up projects. Where there was one intercontinental ballistic missile, there now are two; where there was one IRBM, two now flourish, and there may soon be three.

Biggest question about the new position of missile czar was not who would be named, but at what level he would fit into the multi-layered missile management. His effectiveness will be determined almost solely by his position in the organization. "Nobody pays any attention to the office boy," said one observer, "and this man had better be on the board of directors."

There is hope that appointment of a missile czar will do much to eliminate the many routes along which decisions are made and communicated in the guided missile program, particularly in its long-range ballistic phases.

If such a position carries with it authority to cut across channels and to tread on toes, then it is well along to success. If the czar is to be just another subordinate to the many military and civilian levels of authority, then the appointment will be a farce.

The organization chart of the long-range ballistic missile program is not a clear one. In some respects it resembles the society of a chicken yard, where a pecking order is established, and a hen may peck only on another hen whose inferior position has been established by skirmishes and precedent.

It is into this menage that Secretary of Defense Wilson now proposes to throw another animal. It will soon be established whether the stranger is a fox or a hen.

More, Merrier?

Adding projects to the current missile program seems like the height of folly to many observers. They argue that the "crash" program, based on organizational lines like the Manhattan project

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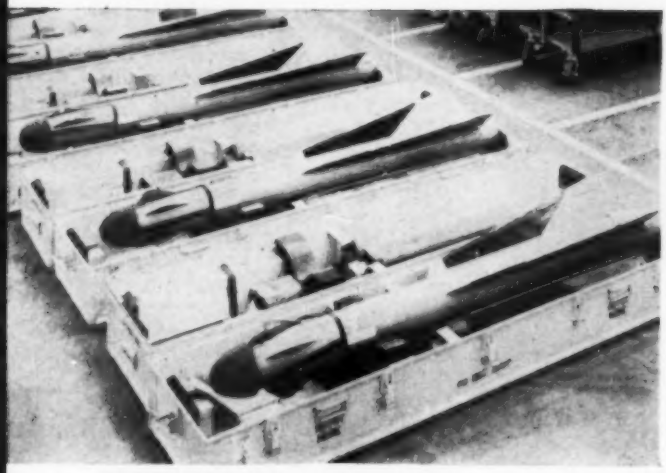
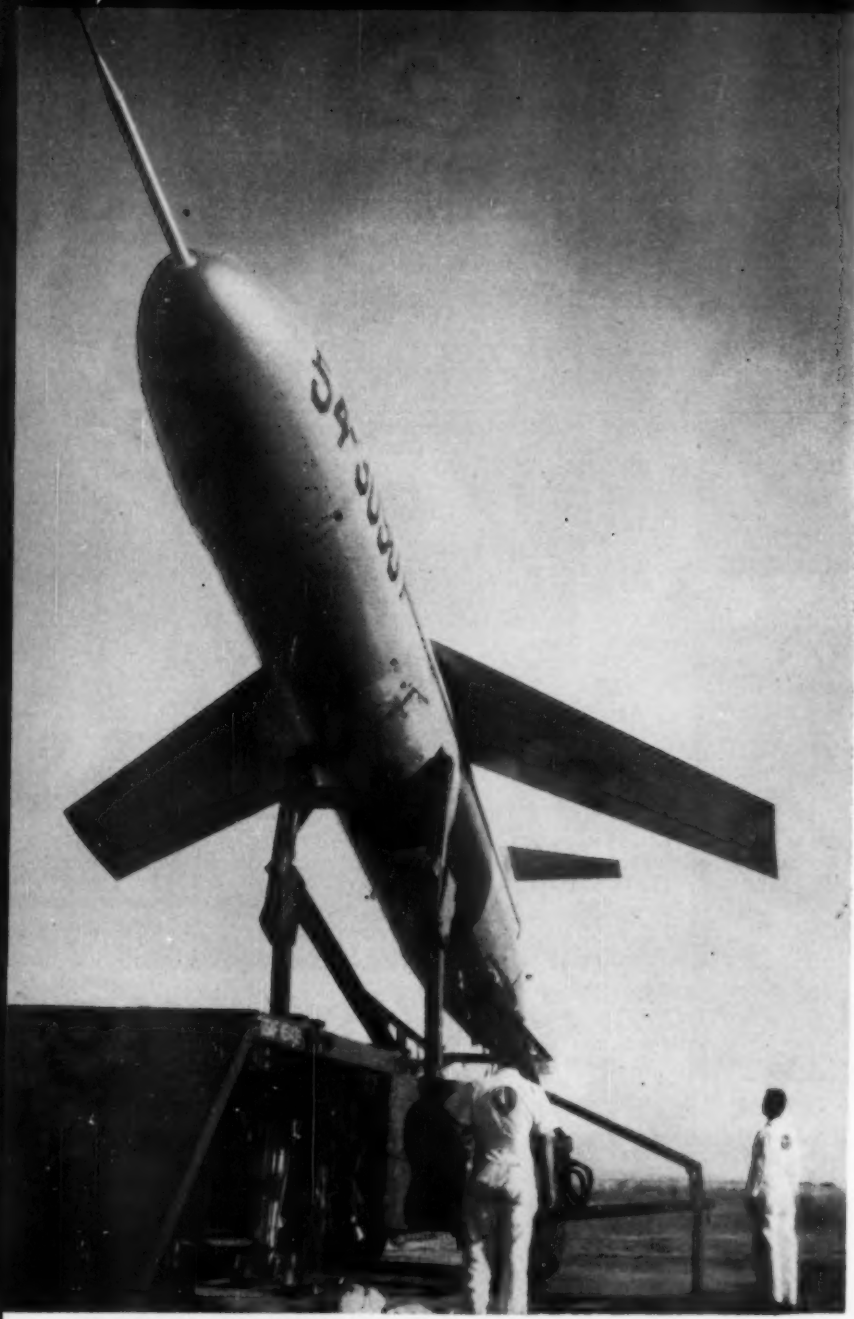


HUGHES FALCON

NORTHROP SNARK



MARTIN TM-61B MATADOR

of World War II, is the only way to organize the ballistic missile program. They ask for a latter-day Peenemuende, with all the responsibility and authority for missile development concentrated in a single agency.

The counterview is that such a program is too much of a gamble. If the wrong technical decision is made at the start, the country will wind up without a useful weapon. Parallel development programs are insurance.

Engineering approaches favor the scatter-gun technique: try enough avenues, and you'll find that one road leads to your final destination. But there are many practical difficulties.

Each missile project of necessity must go to the same sub-systems suppliers. There are only two developers of gigantic rocket motors: Aerojet-General and Rocketdyne division of North American Aviation.

The same holds true for guidance. General Electric and American Bosch Arma are the only firms with current contracted capability in the guidance of extremely long-range missiles. Both are likely choices for prime and second-source contracts in their field.

The critical warhead, with its blunted nose cone, also is available only from two sources: General Electric and Avco.

Parallel projects also compete for the unique long-range test site operated by the Air Force for all three services at Patrick AFB. They compete for a chunk of the limited funds earmarked for research and development.

Conceivably the parallel approach could establish a current maximum of five projects, with six systems subcontractors sharing a possible minimum of 15 contracts. Range test firings would be scheduled at more than twice the number required for one missile in each of the ICBM and IRBM classes.

Contrast this with a single agency monitoring two projects that draw on six sub-systems suppliers with one contract apiece.

Accomplishments

There is a danger here: In the present fracas over the missile program it is too easy to overlook the outstanding technical work accomplished in almost all missile fields. While the glamor is attached to the ICBM, the short-range or defensive or subsonic weapons have progressed to the point where eight of them stock the missile arsenal as issue items for the military. Others are at a high developmental level, but have not yet been ordered in large-volume production.

One of these—the Northrop Snark—is the only available long-range missile now in this country. Snark has been developed to a high technical level in the past ten years. It is a combat-ready weapon system, with an accurate, operationally proven navigational system. It can do the job of a B-52, say its backers, and for much less money and much less logistic support.

Snark could be a service weapon much sooner than any ballistic missile now under development; it could be in service before some comparable bomber deliveries are completed.

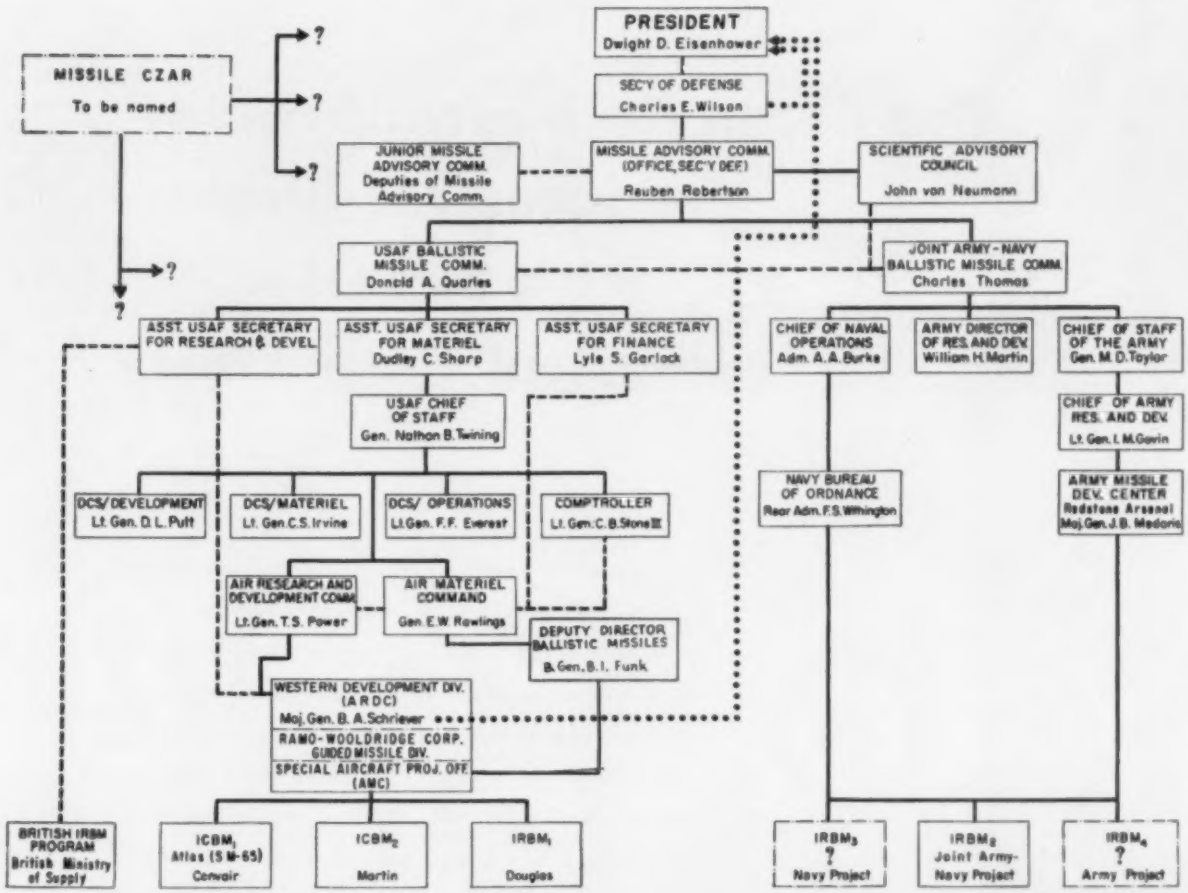
Shooting Gallery

One sure clue to the state of the ballistic missile art is the status of available test ranges. The only long-distance range in this country is just now being completely instrumented to a distance of 1,200 mi.

There is only one interpretation for this: There has been no requirement for a fully instrumented range of that length for ballistic missiles.

Before this time, most of the down-range stations of the Air Force Missile Test Center at Patrick AFB, Fla. were equipped with early-model tracking radars and optical trackers. These units were completely adequate and accurate for plotting the flight paths of the air-breathing, low-altitude missiles tested along the range.

But this elementary equipment would



PENTAGON MISSILE MAZE

be hard pressed to keep up with hypersonic missiles on ballistic trajectories, even over a short distance.

For that reason, a radar chain—first of its kind in this country—has been developed and installed for the Air Force by Reeves Instrument Corp. This down-range chain will link all tracking stations simultaneously, and collect, compute and present missile flight coordinates back at the firing point.

Firings at the AFMTC have included such weapons as the Martin Matador, Northrop Snark and North American Navaho, all air-breathing missiles. Boeing's Bomarc, which combines rocket launching with ramjet cruise, also has been fired during a test program at the Center. The only ballistic missile of V-2 range, the Army's Redstone, was first fired at AFMTC three years ago.

But no long-range ballistic missile has yet been tested there.

Food for the Motor

Missile powerplant propellants have increased in number from a handful a few years ago to at least a score today. Available from the tank-car quantities of full-scale production down to the laboratory supplies in cubic centimeters worth more than their weight in gold, these new exotic fuels point the way to performance improvements.

High on the list are metals: the light elements of lithium and boron, whose hydride compounds can be both fuel and additive, and aluminum, finely pulverized in a slurry with a hydrocarbon fuel.

The performance of any powerplant that burns a fuel with an oxidizer depends on the heat content of that fuel. The more BTUs packed into a pound, the better the engine performance will be. Or, for a given performance, the higher heat content means a smaller quantity of fuel.

In the special case of a rocket powerplant, where the oxidizer is carried along in the missile tanks, one of the most important engine parameters is the exhaust velocity. This is because speed of the missile is almost always of paramount interest and the missile speed is directly proportional to the speed of the hot blast of the exhaust.

Theoretical jet exhaust velocities have been calculated years ago from the chemical equilibrium of the propellants involved. Thus the rocket experimenter always has known something of the improvement he could expect by using liquid hydrogen and liquid oxygen instead of alcohol and liquid oxygen.

But logistics of supply, the availability of the rarer fuels and the difficulties already known have slowed the use of exotic propellants. It has only been recently that any rocket development unit has been able to look back on considerable experience with gasoline or JP-4 fuel. Small-scale tests have been made on chlorine, fluorine, boron and lithium compounds, but most large-scale operational rocket powerplants are still sticking to the tried and true combinations of fuel and oxidizer.

The light-metal fuels are lithium and boron hydrides. Pentaborane (B_5H_9) has been in limited production for about ten years in this country. During that time, an impressive backlog of tests in rocket motors has confirmed its high heat value, approximately twice that of conventional hydrocarbons.

Two uses are suggested for such fuels: First, they can be used directly as a fuel in combination with a suitable oxidizer; second, they can be added to

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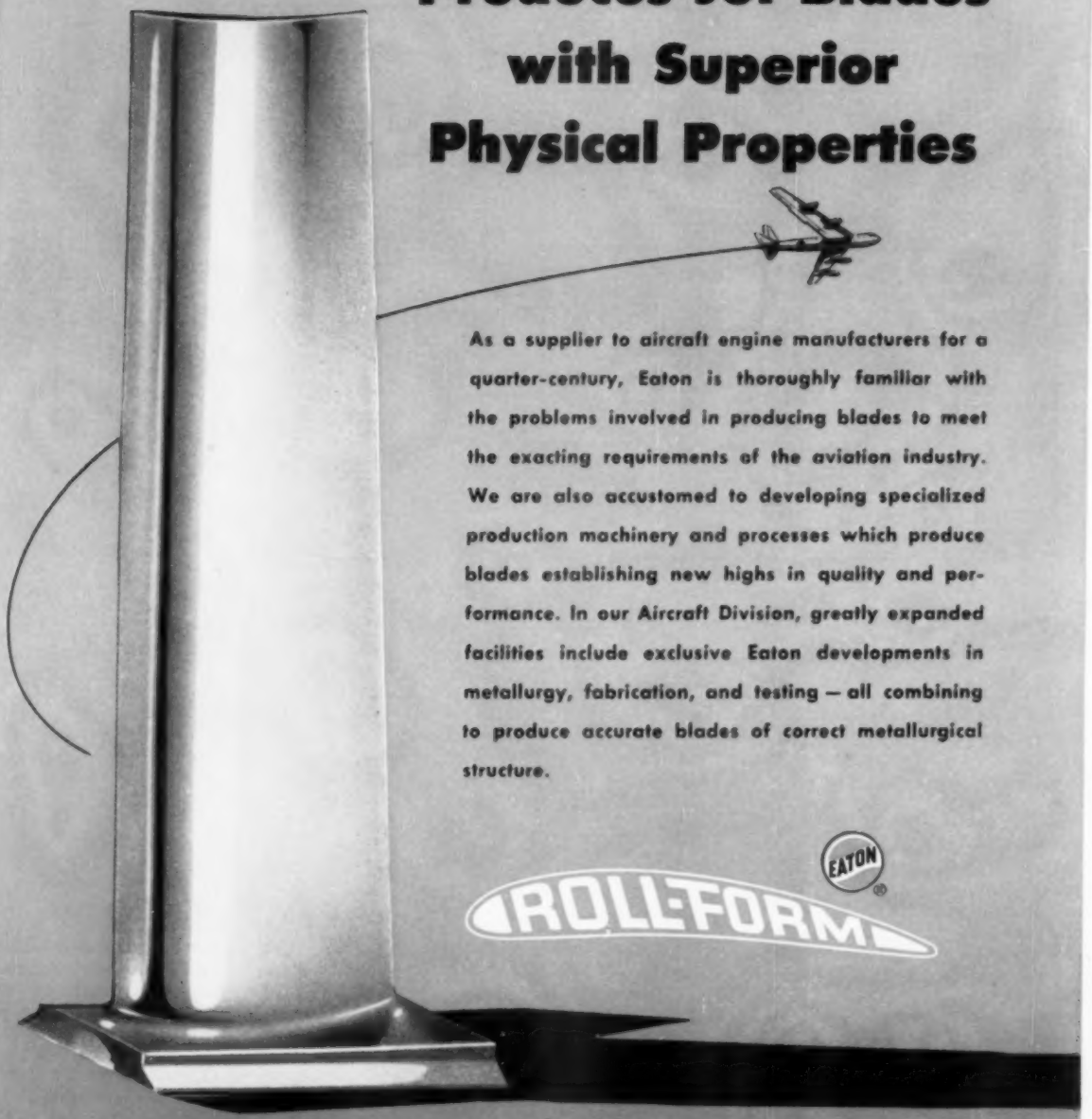

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hydrocarbon fuels—with which they are miscible—to speed up the rate of flame propagation.

The value of these compounds as additives comes from the mechanics of combustion. A fuel has a characteristic flame propagation speed: the rate at which the flame front proceeds through a fuel-air mixture. For gasoline and air, this flame speed is less than 10 feet per second.

In a combustion chamber, combustion efficiency depends on burning all of the fuel. To a designer, this means providing enough distance for the flame front to expand to fill the chamber, and to complete burning. By increasing the flame propagation rate, the flame front fans out faster to fill the combustor and burning is completed in a shorter length of the chamber. Size savings in the combustion chamber are reflected all the way back through the weight and structure of the missile.

Metallic slurries had been tested during World War II by Dr. Eugen Saenger as part of his antipodal bomber study project. He used aluminum, finely powdered and mixed with gasoline.

Defense Against ICBMs.

There were two objectives: the first was to increase the heat content of the fuel, and the second was to increase the mass of the exhaust and therefore the thrust of the reaction to the exhaust.

Saenger's chief difficulty was keeping the aluminum in suspension. Mechanical agitators in the tank kept the mixture moving, but even so there was a tendency toward separation and clogging in the lines.

There are indications that some of these mechanical problems have been solved, and that a slurried fuel is a nearly practical proposition.

Hottest new field of missile technology is that of the anti-missile missile, "antis" in the new jargon of the trade.

The basic problem is an extremely difficult one: To intercept and destroy an intercontinental ballistic missile far enough from its intended target to protect that target.

Studies like these were kicked off during World War II, when the field employment of the German V-2 ballistic missile was creating havoc in the port cities of Antwerp, Calais and London. The problem of intercepting that weapon was technically beyond reach at the time. The reason was the limited available performance of rocket-powered airframes.

The V-2, hurtling downward toward its target, clocked about Mach 5 in its dive. Every second it ripped 5,000 ft. nearer its target. From takeoff to impact, the V-2 was in the air only about five minutes; the task of acquiring it by radar, identifying it, plotting its probable trajectory and then firing an intercepting missile left a very slim segment of time for the anti-missile flight.

Calculations showed that an anti-missile missile would have to have a minimum velocity twice that of the V-2 to give any hope of defending a target against even that rudimentary weapon. And of course, speeds of Mach 10 just were not in the 1946 cards.

Such velocities are feasible now. Technical advances in aerodynamics, structures, powerplants and guidance make a Mach 10 vehicle feasible. The only catch is that those technologies have gone into offensive missile development, and the target for the "antis" no longer loafs along at Mach 5. On the terminal leg of its trajectory, an ICBM will be making about Mach 10, or about two miles per second.

Earlier Warning

But as speeds and ranges have increased, altitudes and times of the flight path also have increased. This means there is a chance to get a much earlier warning of an ICBM attack. With a flight time approaching half an hour, and peak trajectory altitudes of hundreds of miles, the time for defending forces to gather data increases sharply compared to the case of the simple, short-range V-2.

In this data-gathering and plotting process lies the heart of the anti-missile system; with that segment out of the way, hardware development should be relatively simple.

One comparatively recent radar technique might form part of the foundation for this new branch office of missile engineering. Mortar-locating radar —MPQ/10, developed by Sperry Gyroscope Co.—was used in the late stages of the Korean war to spot positions of enemy mortar batteries. By tracking the shell in flight and calculating its trajectory back down to the firing point, such radars could plot coordinates for an air or artillery strike.

This particular Sperry radar has been used in missile experiments during test firings of short-range missiles, presumably the Army's Corporal or Redstone. For these tests, the MPQ/10 tracked the missile after takeoff and predicted coordinates for its impact point.

Warhead Fallout

Strength of the new warheads plays a most important part in anti-missile system design. A V-2 high-explosive warhead detonated at 10,000 ft. would have caused only minor damage in the target area. An ICBM bearing a thermonuclear warhead, or one of the newer 3-F charges, would be just about as effective at 10,000 ft. as at sea level.

Currently three teams are working on the problems of the "antis": Bell Laboratories, under a $12-million Army contract; North American Aviation, Inc., and the Convair division of General Dynamics.

These are only a few highlights of one of the most complex technical and organizational fields ever to tax the engineering and management mind. The future success of the guided missile program depends on the current redirection of effort. If the right man makes the right decisions at the right level, we can regain the ground lost to the Russians.

One of the unusual problems of the anti-missile missile is inherent in the flight of its target. The oncoming ballistic missile, traveling at hypersonic speed, generates a huge contrail of ionized gas particles. Those particles will give as strong a signal as the missile itself, and in some cases, a stronger signal.

Then the problem is the ability of the tracking radar to distinguish between the missile and its flight path, stenciled in space by ionized gases.

Guided Missile Money—1954-1957

NEW OBLIGATION AUTHORITY

(in millions)

	USAF	Navy	Army	Total
1954	364	159	225	748
1955	219	126	...	345
1956	700	238	...	938
1957	1,422	354	...	1,776

EXPENDITURES

	USAF	Navy	Army	Total
1954	176	141	187	504
1955	305	176	150	631
1956	485	172	260	917
1957	799	177	281	1,257

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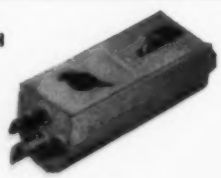

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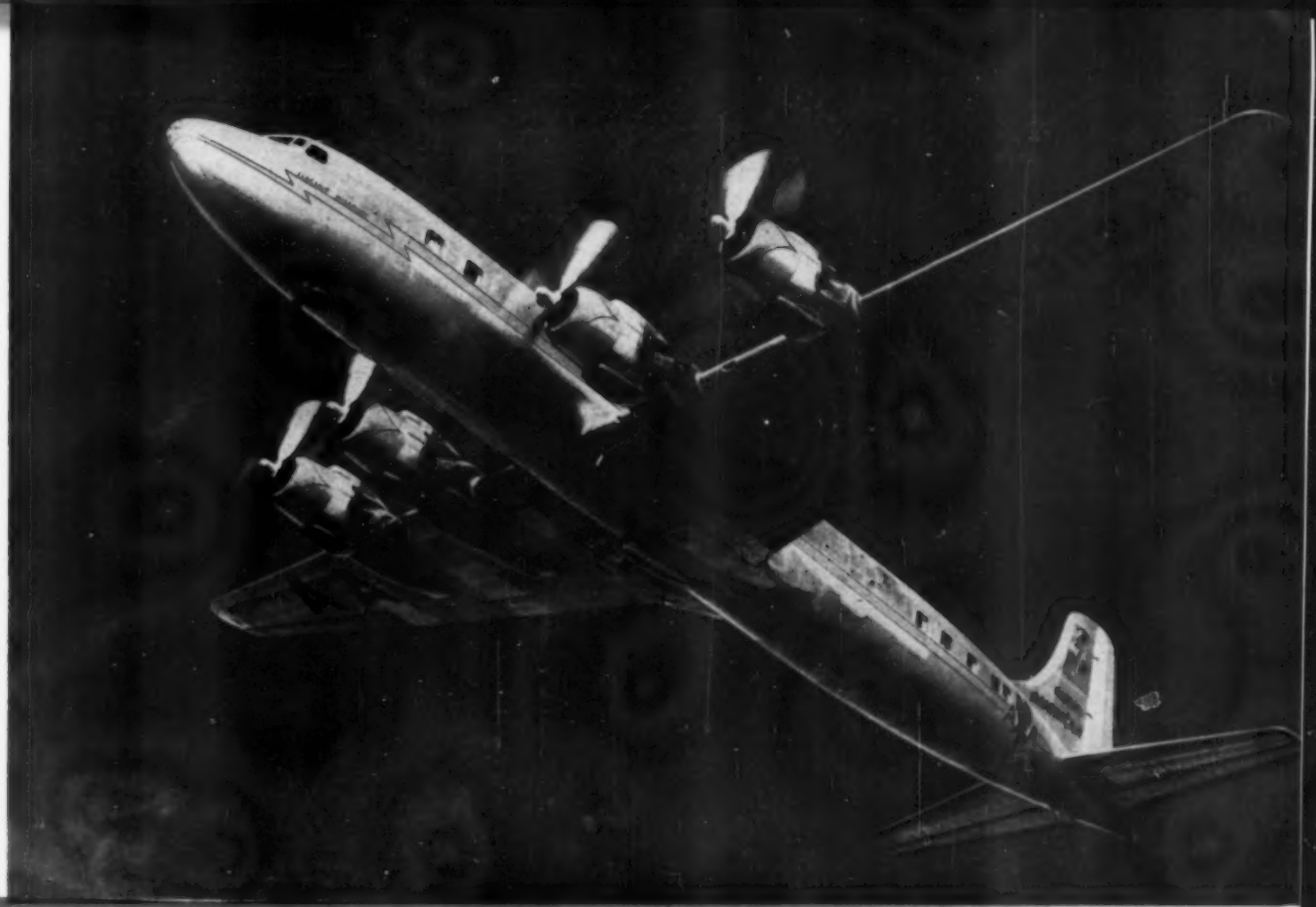

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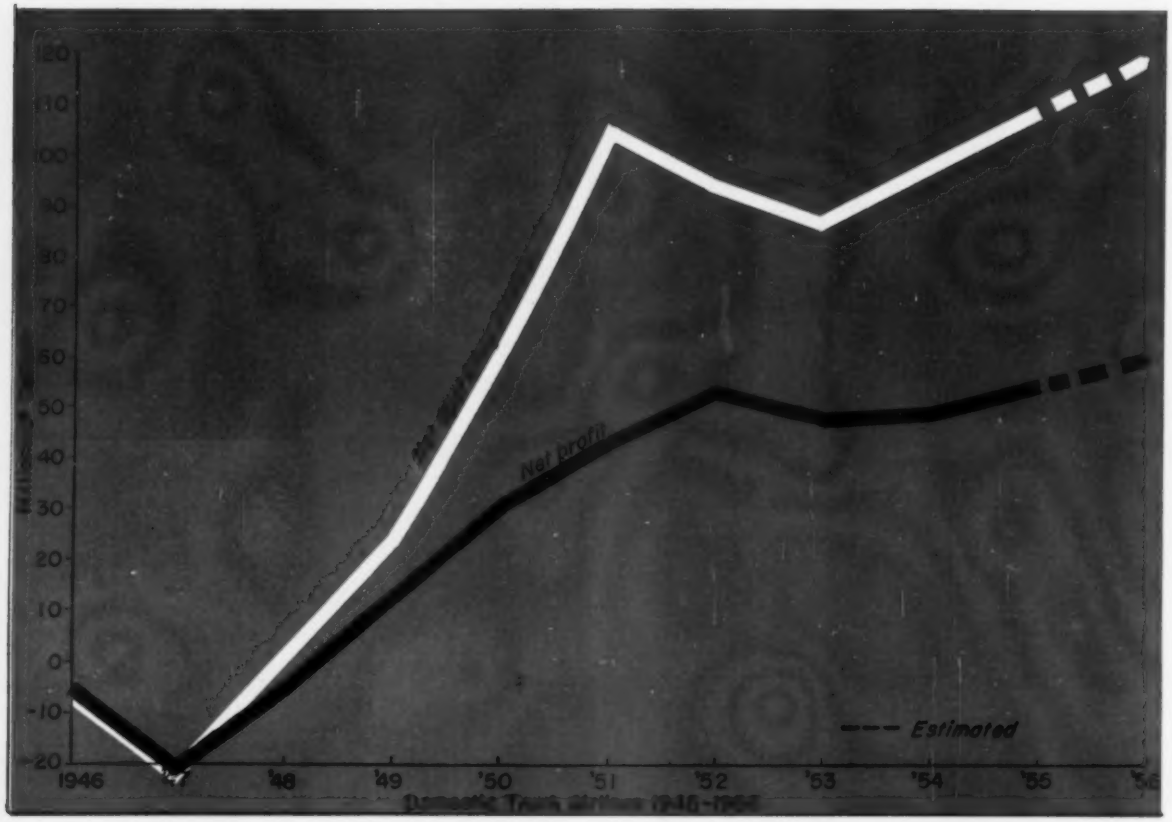

Prosperous Trunk Lines Enter Jet Era

By Craig Lewis

The past year has been a turning point in the history of the nation's trunk airlines. It marked the end of one tremendous period of growth and the beginning of an even greater and more vital era of expansion.

Airline business in 1955 was the greatest ever by a wide margin, capping a ten-year period of development in which revenues more than tripled. At the same time, a base for future expansion has been laid with widespread purchases of turbine transports and a massive realignment of routes and competition.

Traffic and revenues broke all records last year. Passenger traffic increased 20% with substantial gains in both first class and coach business, and revenues were up 16%. Profits increased substantially from the previous year's plateau.

Orders Top $1 Billion

The airlines ended the year with over $1 billion worth of equipment on order, the bulk of it turboprop and turbojet transports. The jet era really got under way late in 1955 with a rush of orders for Boeing 707 and Douglas DC-8 transports.

Civil Aeronautics Board acted in a series of important cases to rearrange the trunkline route pattern. These major decisions were designed to strengthen the smaller trunk airlines and increase competition on the nation's air routes.

Trunk airline traffic increased in all categories last year. Revenue passenger-miles gained 19% and revenue ton-miles 20%. Express and freight increased 22% and 25% respectively. Mail traffic lagged with a gain of only 9%.

Revenues showed similar improvement, with total operating revenues passing the $1 billion mark for the first time. Passenger revenue alone was slightly more than $1 billion. Decreases were registered in mail revenue and subsidy, since CAB adjusted the rates downward during the year.

Operating income and profits will show even better gains when final tabulations for the year are completed. Estimates indicate that, in spite of a disappointing fourth quarter, profits increased about a third over the 1954 level, easing worries about narrowing profit margins prevalent a year ago.

Last year's phenomenal airline prosperity was tied closely to the high national rate of economic activity. Economists expect the economy to continue to operate at a high rate at least into the third quarter. The airlines are expected to continue their heavy gains through 1956, since even a fairly serious reversal of the general economic trend probably wouldn't be felt by the industry before early fall.

Jet Era Starts

The future form of airline service took shape this year in a series of crucial commitments for turbine aircraft. Operationally, the effect of turboprop and turbojet transports won't be felt

until 1960, but there can be no doubt that 1955 marked the beginning of the jet era for the nation's domestic airlines.

The orders began with the decisions of American Airlines and Eastern Air Lines to buy the Lockheed Electra for their turboprop transport. Then last fall, United Air Lines ended a long period of speculation with the announcement of an order for Douglas DC-8 transports. American, Braniff Airways, Continental Air Lines and Trans World Airlines have followed with orders for the Boeing 707, and Eastern, National Airlines and Delta Air Lines have decided to buy the DC-8. Braniff and National also ordered Electras.

The decision to buy turbine types was an expensive one and had to be based on several unknowns, a major one being whether traffic will develop sufficiently to fill the tremendous increase in capacity represented by the jets.

Many airline executives would have preferred to wait awhile before going into jets, but competitive factors dictated an immediate decision. Speed and novelty are key factors in selling air transportation, and as soon as one airline ordered a jet, they all had to make the move.

While they are waiting for the jets, the airlines have an immediate capacity problem brought on by traffic growth and large scale awards of new routes. Douglas, Lockheed and Convair are busy filling orders for piston-engine transports which have proven themselves reliable performers. The airlines feel that such types as the DC-6/DC-7 series and the Super Constellation series will furnish the bulk of capacity for years to come, even after the jets go into service.

Actually, the jet age came to the United States when Capital Airlines started service with Vickers Viscounts last summer. Capital will have a three-year jump on the other trunk carriers before they will have turboprops in service. Viscounts didn't arrive in large enough numbers to have a substantial effect on Capital's 1955 results, but the carrier reports good public response and high load factors for its Viscount service, most of which is concentrated between Washington and Chicago.

BOEING 707

Financial Maturity

Financial problems involved in ordering the expensive jets demonstrated that the airlines have reached a new position of maturity. The high costs of the new transports are beyond the capabilities of the usual practice of paying for new aircraft out of reserves and earnings with the help of short-term financing. Insurance companies and other financial sources are willing to give the airlines substantial money for periods up to 40 years.

While traffic and revenue are expected to continue their growth over the next few years, the profit picture is much hazier. The main reason for this lack of clarity lies in the large number of routes and services awarded by CAB in the past year. Many carriers will be engaged in establishing themselves com-

VICKERS VISCOUNT 700D

Domestic Trunklines—Estimated Traffic, Revenues and Expenses—1954, 1955

Item	1955	1954	Percent Change
Traffic			
Revenue Passengers	34,513,000	29,561,000	16.8
Revenue Passenger-Miles	19,375,000,000	16,288,420,000	18.9
Mail Ton-Miles	86,750,000	79,657,000	8.9
Express Ton-Miles	50,200,000	40,165,000	25.0
Freight Ton-Miles	176,175,000	144,432,000	22.0
Revenue Ton-Miles	2,225,000,000	1,852,369,000	20.1
Revenues			
Passenger	$1,016,560,000	$872,124,000	16.6
Mail	30,770,000	33,220,000	−7.4
Express	19,483,000	15,093,000	29.1
Freight	39,551,000	33,000,000	19.8
Other	24,419,000	19,950,000	22.4
Operating Revenues	1,130,783,000	973,387,000	16.2
Public Service	2,773,000	3,700,000	−25.1
Total Revenues	1,133,556,000	977,087,000	16.0
Total Expenses	993,324,000	877,620,000	13.2
Operating Income	140,232,000	99,467,000	40.9

Subsidy Estimates, Fiscal Years 1951-1957

	1951	1952	1953	1954	1955	1956	1957
	(In Thousands)						
Domestic Trunks	$18,881	$6,411	$3,527	$3,880	$3,059	$2,193	$2,187
Local Service	17,310	18,990	21,800	24,570	23,040	24,088	23,808
Helicopters	.....	.....	.....	2,574	2,657	2,814	2,803
States-Alaskan Operations	792	2,075	3,226	3,391	3,393	3,152	3,312
Intra-Alaskan Operations	2,484	3,356	4,639	4,945	4,530	3,723	3,674
Hawaiian Operations	48	715	871	684	293	293	293
Transatlantic Operations	16,121	10,656	9,034	1,299	.....	635	2,273
Transpacific Operations	10,776	11,641	12,173	8,719	378	.....	.....
Latin American Operations	10,245	14,511	15,471	16,116	10,154	6,339	8,136
Total	**76,657**	**68,355**	**70,741**	**66,178**	**47,505**	**43,237**	**46,486**

Leadership in Intercity Passenger Traffic

Comparison of Air, Rail & Bus Revenue Passenger-Miles: 1955
(Domestic, Excluding Commutation) (000,000 omitted)

1.	Greyhound Corporation[1] 4,689	12.	N. Y., N. H. and Hartford ... 1,200
2.	American Airlines 4,318	13.	Delta Airlines 966
3.	United Air Lines 3,800	14.	Southwestern Greyhound 878
4.	Eastern Air Lines 3,344	15.	National Airlines 858
5.	Pennsylvania RR 3,303	16.	Northwest Airlines 827
6.	New York Central 2,876	17.	Capital Airlines 795
7.	Trans World Airlines 2,852	18.	Chicago, Burlington and Quincy 736
8.	Pacific Greyhound 1,926	19.	Chicago and North Western .. 696
9.	Atchison, Topeka and Santa Fe 1,915	20.	Chicago, Rock Island and Pacific 671
10.	Union Pacific 1,418		
11.	Southern Pacific 1,304		

[1] Includes Eastern, Florida, Great Lakes, Northwest, Overland and Southeastern operating divisions.

Air traffic estimated on basis of 11 months reported.
Rail traffic estimated on basis of 10 months reported.
Bus traffic estimated on basis of 9 months—passengers carried.
Source: Air Transport Assn.

petitively in new markets, as well as meeting new competition on their old routes.

The new competitive situation won't be felt fully for awhile—maybe for as long as two years. None of the airlines has the equipment to take full advantage of the new opportunities. Where new services are being inaugurated, it usually means canceling schedules on other routes. It will be well over a year before deliveries of new equipment will give the airlines some added capacity to exploit the new routes.

The recurring philosophy voiced by the CAB in its decision on three major cases last fall—the New York-Chicago case, the Denver case and the Northeast-Southwest case—was that it was trying to build the regional carriers as more effective competitors of the Big Four. The Board said it was trying to narrow the tremendous size gap between the Big Four, which do 75% of the trunk business, and the remaining nine carriers which are left with 25%.

The decisions in the three cases have brought route changes of varying degrees to 10 of the 13 trunk airlines. Most of the awards took airlines into areas where they had not operated before, offering major competition on many routes for the first time:

• **Capital was the first** carrier to benefit from the new philosophy. In the New York-Chicago case, the regional carrier was promoted to the status of major competitor with United, American and TWA in the area between New York and Chicago and got a new New York-Buffalo-Detroit route. Later, Capital's route pattern in the south was altered to allow the carrier to compete more effectively between the northeast and Atlanta and New Orleans.

• **Braniff Airways** was brought into the New York market from Dallas in a completely new route outside its western pattern. The new service, via Memphis, Nashville and Chattanooga, offers competition on a route formerly dominated by American.

• **Delta also entered** the New York market and was extended to Houston. The new route primarily means new competition for Eastern between Houston and the northeast, but it also means Delta, along with Capital, will offer stiff new competition for Eastern between New York and other northeastern points and such southern markets as Atlanta and New Orleans.

• **Continental's isolated** western route pattern was extended to the east and west so that the airline has a new Chicago-Los Angeles route via Denver and Kansas City. Continental must establish itself in this new market in competition with TWA, United and American.

• **Northwest Airlines was given** Chicago

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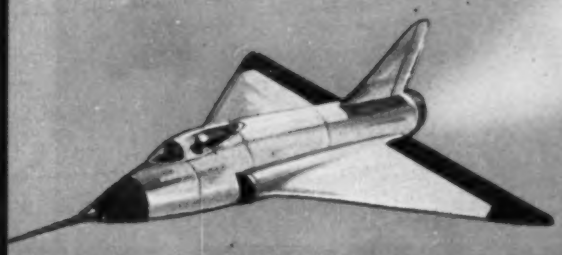

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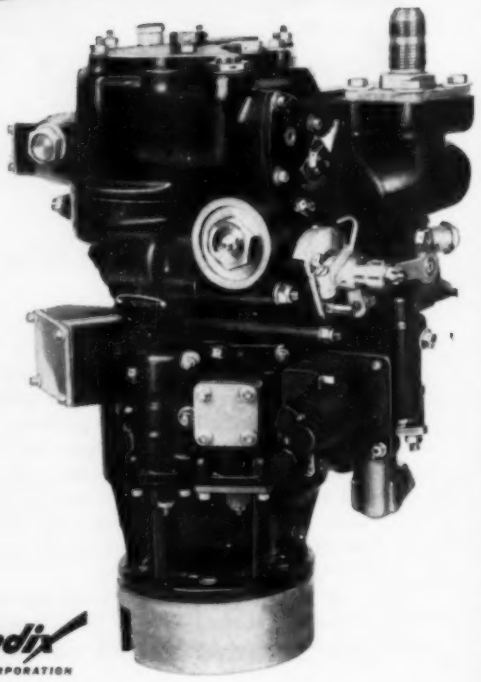

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Aircoach Statistics—1955, 1954 and 1953

Carrier	Passengers			Passenger-Miles		
	1955	1954	1953	1955	1954	1953
American	1,006,000	610,176	368,082	1,155,235,000	754,500,000	562,526,000
Braniff	76,000	29,980	2,732	39,906,000	16,296,000	1,561,000
Capital	238,000	331,629	266,047	117,811,000	146,851,000	131,742,000
Colonial	26,000	27,005	39,607	7,880,000	8,177,000	11,555,000
Continental	30,000[1]	.....	.....	27,306,000	.....	.....
Delta	390,000	228,333	139,440	280,000,000	165,378,000	108,987,000
Eastern	1,429,000	1,030,206	714,045	1,455,795,000	872,801,000	649,692,000
National	520,000	420,566	309,544	478,945,000	392,281,000	303,090,000
Northwest	333,000	322,894	310,419	295,232,000	293,750,000	291,759,000
TWA	1,325,000	1,078,773	720,051	1,483,262,000	1,370,908,000	1,027,702,000
United	1,206,000	869,108	574,751	1,150,346,000	847,225,000	535,256,000
Western	342,000	295,126	218,899	169,733,000	148,844,000	102,201,000
Totals	**6,921,000**	**5,243,796**	**3,663,617**	**6,662,429,000**	**5,017,011,000**	**3,726,071,000**

[1] Estimate.
Source: CAB reports.

as a point on its transcontinental route, and the carrier was chosen for a new Detroit-New York service.

• **Western Air Lines got** a Denver-San Francisco segment via Salt Lake City and Reno which fills a gap in its system. Western will compete with TWA and United on the route.

• **American Airlines entered** the travel markets at Houston and Pittsburgh and was permitted to offer a third nonstop service between Chicago and San Francisco in competition with United and TWA.

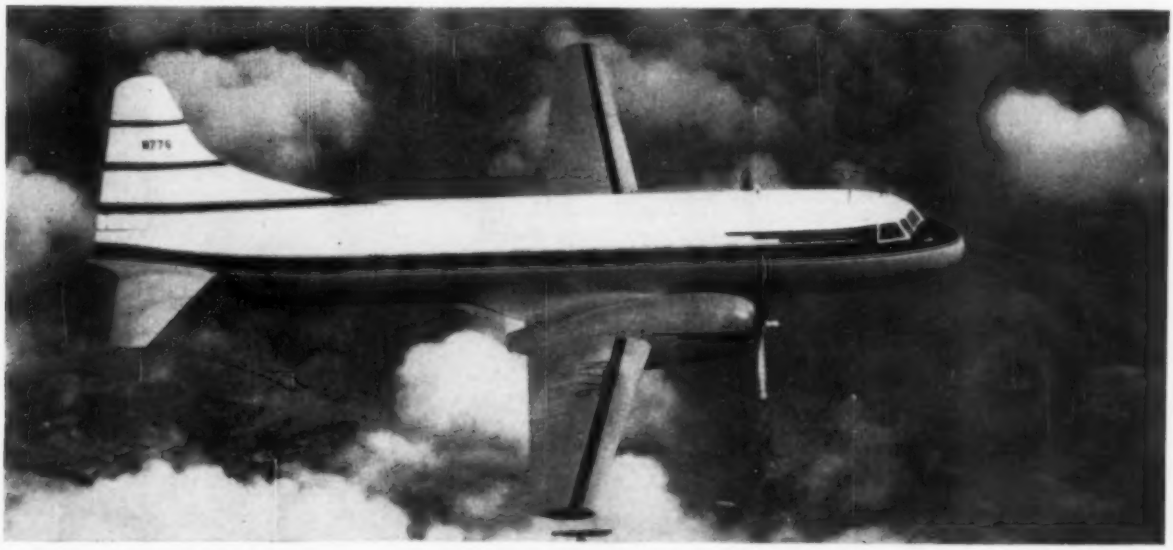
• **United added Pittsburgh** to its system and was permitted to serve Kansas City, long a TWA preserve on east-

Average Passenger Yield

Cents per Mile

	First Class	Aircoach	Total
1955	6.02	4.35	5.34
1954	5.90	4.15	5.36
1953	5.88	4.13	5.44
1952	5.87	4.16	5.55
1951	5.76	4.47	5.59
1950	5.74	4.17	5.54
1949	5.81	3.98	5.76
1948	5.74	....	5.74
1947	5.03	....	5.03
1946	4.62	....	4.62

Source: CAB Annual Airline Statistics and Recurrent Traffic Reports.



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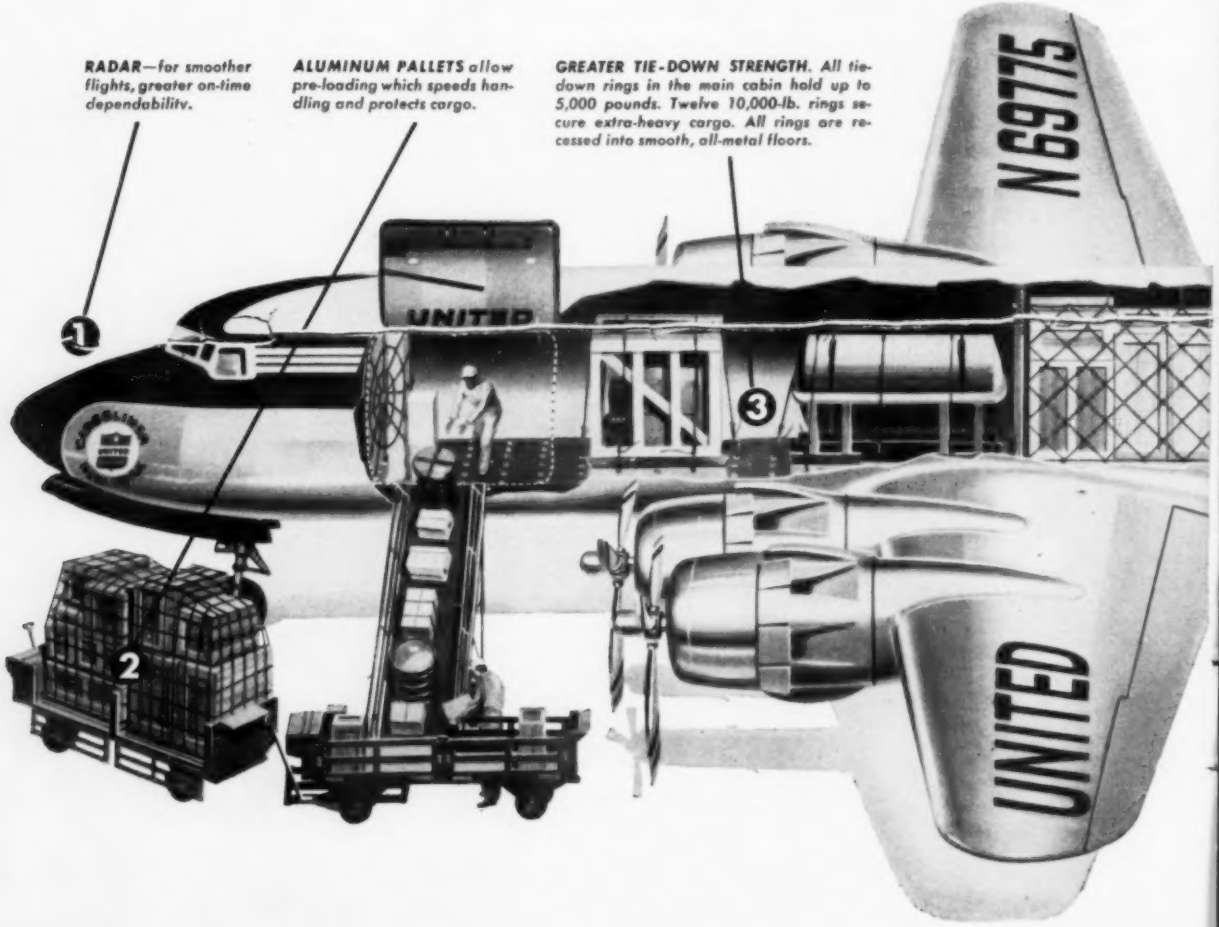
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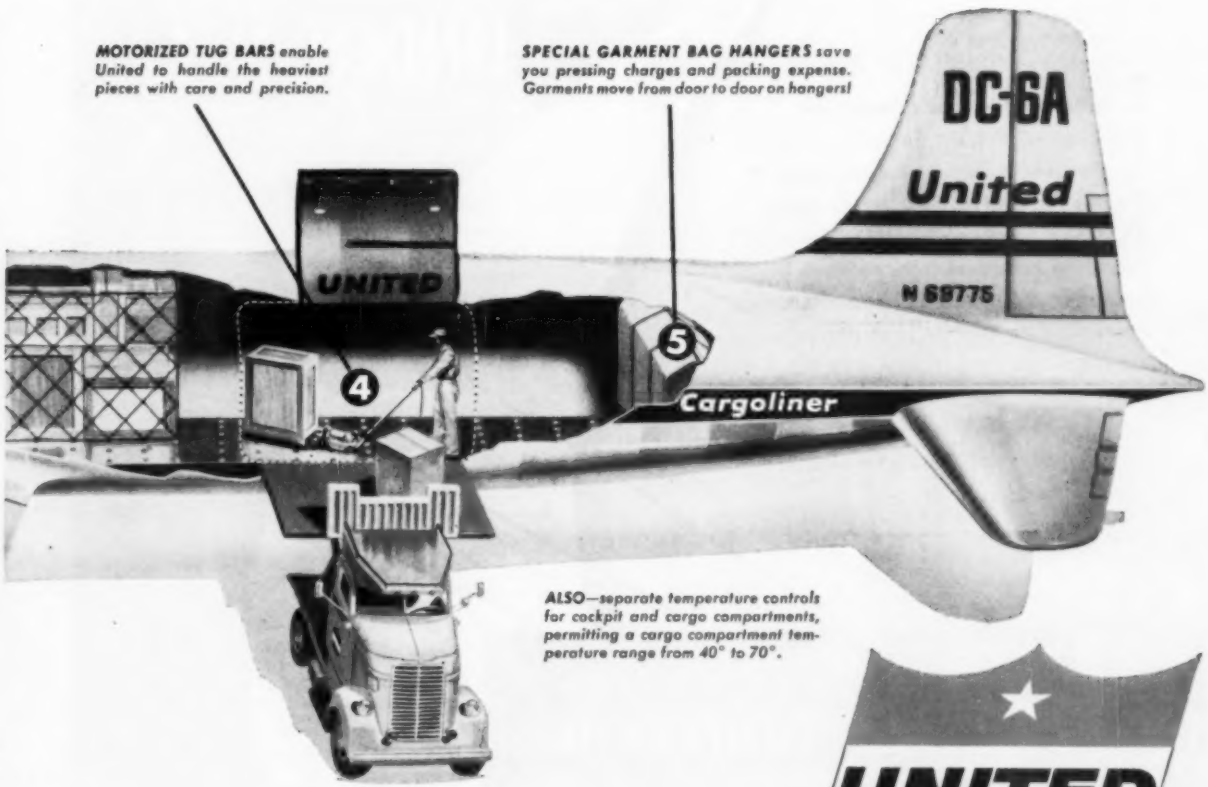
MOTORIZED TUG BARS enable United to handle the heaviest pieces with care and precision.
SPECIAL GARMENT BAG HANGERS save you pressing charges and packing expense. Garments move from door to door on hangers!
DC-6A
United
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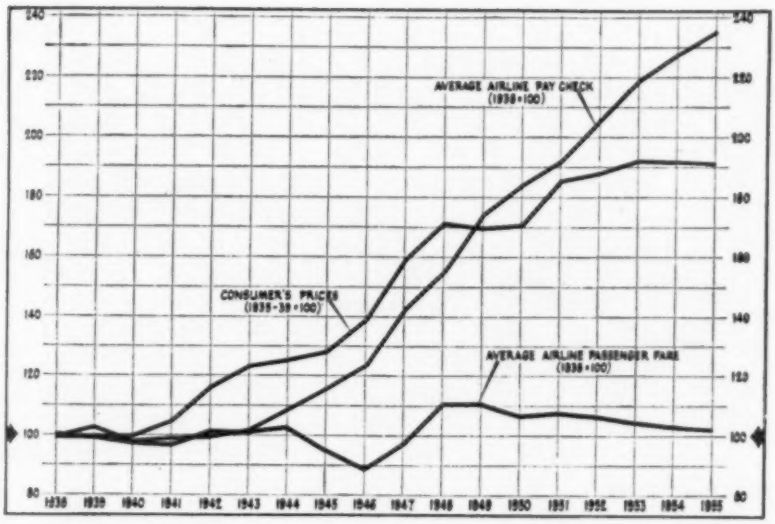
UNITED
4
5
Cargoliner
ALSO—separate temperature controls for cockpit and cargo compartments, permitting a cargo compartment temperature range from 40° to 70°.

UNITED AIR LINES

A NEW
babb
EXPANSION
to serve the Atlantic Coast
at
LINDEN, N. J.
To better serve Atlantic Coast and European clients, the Babb Company, Inc. has just acquired new expanded facilities at Linden, New Jersey. Here 44,000 sq. ft. of servicing facilities, including three test cells, now are in operation. Babb's former operation at Newark, N.J., has been transferred to Linden to bring together in a single location a complete and modern engine, propeller, and accessory overhaul and maintenance service for aircraft owners and operators.
THE babb COMPANY, INC.
"More than a quarter of a century of service to the Aircraft Industry"
Home office:
Sky Harbor Airport,
Phoenix, Arizona
Linden, N. J.
St. Johns, Quebec, Canada
Glendale, Calif.
Miami, Florida
London, England
Rome, Italy
Damascus, Syria
Washington, D. C.
Paris, France
Brussels, Belgium
Zurich, Switzerland



west services. United was also freed from operating restrictions between Philadelphia and Detroit, and at Ft. Wayne, Ind.

• **Trans World Airlines was chosen** to offer United its first east-west competition at Denver. Tulsa and Oklahoma City were added to TWA's system to give American competition on transcontinental service, and Detroit was added to the airline's New York-Chicago route.

• **Eastern gained the least** in the three cases, having to be content with the removal of closed door restrictions at Pittsburgh which permits better service to Akron, Cleveland and Detroit and to southern points.

New Florida Decision

A fourth important case will be decided this year. In it, new competition on New York-Florida routes will emerge for Eastern and National. Northeast Airlines has been a leading contender for the new route, but it remains to be seen whether the philosophy applied to

Load Factors

Average Passenger Load Factors of the 13 Certificated Scheduled Trunk Airlines for 1954 Compared with 1955.

	1954	1955
American	68.11	67.99
Braniff	62.48	61.55
Capital	58.69	62.31
Colonial	58.46	53.33
Continental	54.31	53.46
Delta	60.07	63.93
Eastern	58.48	60.96
National	59.58	64.09
Northeast	55.92	59.22
Northwest	60.34	59.72
Trans World	68.11	64.63
United	65.99	69.31
Western	55.77	59.10
AVERAGE	60.02	64.47

Source: CAB Annual Airline Statistics and Recurrent Traffic Reports.

Comparative Direct Operating Costs

(Cents per U. S. domestic plane-mile, 9 months ending Sept. 30.)

	1954				1955			
	Flying Operations	Direct Maintenance	Depreciation Charges	Total Direct Operating Costs	Flying Operations	Direct Maintenance	Depreciation Charges	Total Direct Operating Costs
DC-3	33.71	11.25	3.24	48.20	34.21	11.16	1.47	46.84
DC-4	45.51	19.97	3.60	69.08	46.48	20.83	1.08	68.39
CV-240	41.92	24.97	13.39	80.28	40.11	19.83	12.54	72.48
CV-340	41.82	15.73	19.31	76.86	42.65	18.20	17.06	77.91
MARTIN 4-0-4	42.75	19.05	27.85	89.65	42.10	18.65	25.60	86.35
DC-6	55.07	19.35	18.88	93.30	52.36	20.06	9.32	81.75
DC-6B	59.18	19.49	18.31	96.98	62.83	19.17	16.89	98.89
L-749	61.50	25.48	13.87	100.85	61.94	26.80	9.62	98.36
L-1049	69.13	28.38	37.17	134.68	69.25	30.42	35.06	134.73
B-377	82.98	41.66	43.53	168.17	90.26	36.47	35.21	161.94
DC-7	58.70	29.61	32.94	121.25	60.38	27.62	28.18	116.18

Source: Airline Finance and Accounting Conference.

New
ROTOCHUTE
for Pinpoint Drops

Working with the Office of Naval Research, Kaman Aircraft is developing a new concept of air supply for confined combat areas. The Rotochute will permit the dropping of supplies from low-flying high-speed aircraft into restricted areas with pinpoint precision. Supply planes will fly under the range of antiaircraft fire at jet speeds. Lifesaving supplies will land in "friendly territory." The Rotochute is another example of the advanced research and development programs being carried out by Kaman in the National Defense effort.

KAMAN
THE KAMAN AIRCRAFT CORPORATION
BLOOMFIELD, CONN.

last year's decisions will decide this one. Of the CAB majority that carried the decisions on the first three cases, Josh Lee has left the Board, and Chairman Ross Rizley is leaving this spring. It remains to be seen how their replacements feel about the situation.

New Competition

An important decision made by the CAB late in 1955, which is causing the trunk airlines some concern, is the ruling in the Large Irregular Case. Here the Board introduced some potentially strong competition for the trunks by authorizing a new class of supplemental air carriers to conduct unlimited charter operations and operate up to ten flights a month in common carriage between any two cities. Ultimate effect of the decision is difficult to assess, since it remains to be seen whether the new supplemental carriers will try to operate in the style of such coach combines as North American Airlines and whether they will be able to finance enough modern equipment to offer serious competition.

After several years of negotiation and litigation, CAB and President Eisenhower decided to allow Eastern and Colonial Airlines to merge. When Eastern adds Colonial's Canadian and Bermuda routes to its system this year, the ranks of the trunk airlines will be reduced to twelve.

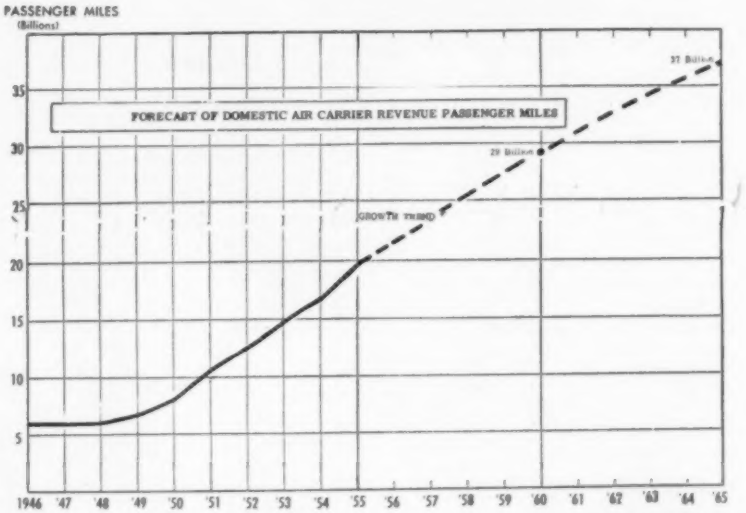
Last year, Continental Air Lines and Pioneer Air Lines consummated a long-pending merger that had been approved by the CAB in 1954.

Mail Pay Decline

The decline in mail pay last year while mail traffic was increasing is due to a new service mail rate formula established by the CAB. The new rates are based on a multi-element system which pays a line-haul rate of 30.17 cents a ton-mile and terminal fees based on a sliding scale ranging from 3.32 cents to 33.21 cents a pound.

As in past years, trunk aircoach traffic showed substantial gains in 1955. Coach traffic grew 25% in terms of passenger-miles, while total traffic increased only 18%. In spite of these gains, coach business advanced only two percentage points over last year to a position of 34.5% of total traffic. This is attributed to the fact that 1955 was a very good year for first-class traffic, and that element kept pace with aircoach growth.

LOCKHEED ELECTRA



CAB FORECAST

$160 Coach Fare

A new element was introduced into the coach picture last August when TWA announced it would offer a $160 round trip coach excursion fare on high-density routes between east and west coast points.

American and United Air Lines followed TWA's lead, and the new low-cost excursion rates became effective in September.

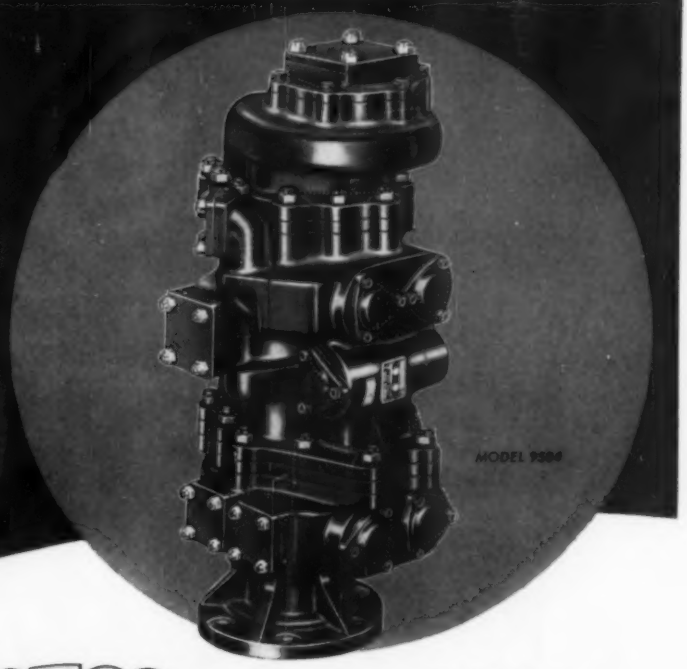
TWA says that it has had great success with the new fares, as well as with its new combination class Super-G Constellation service. American and United are more cautious, but all three carriers have asked the CAB to renew the fare —United and TWA for six months and American for sixty days from the March expiration date.

The major dark spot on the 1955 trunk airline record was safety. The airlines had seven accidents and 156 passenger fatalities during the year for a fatality rate of .78 per 100 million passenger-miles. These figures don't include the tragic United Air Lines' DC-6B crash at Longmont, Colo., last November, caused by explosion of a time bomb.

Total Traffic on U. S. Common Carriers

	FISCAL 1955		FISCAL 1954	
	Passenger-Miles	Percent of Total	Passenger-Miles	Percent of Total
Air	1,390,618,130	39.2	1,110,203,058	33.8
Bus	466,229,395	13.1	534,993,680	16.3
Rail	1,690,618,378	47.7	1,636,890,876	49.9
Total	3,547,465,903	100.0	3,282,087,614	100.0

There IS a BIG difference in fuel pumps



...and the CECO SERVICE RECORD *proves it!*

Not by unsubstantiated claims . . . not on the drawing board . . . but by thousands of dependable hours *in the air* under every conceivable flight condition, CECO Fuel Pumps have *proved* there *is* a big difference in pump performance.

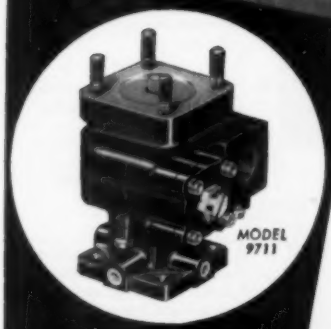
And there are good reasons behind this difference:

GEARS . . . To eliminate the "white layer" problem, CECO gears are made of Nitralloy Steel, hardened, and the teeth *ground* (not shaved) . . . the result is maximum durability and accuracy.

BEARINGS . . . are fully supported and plated with "shoeblack" . . . an exclusive CECO material and process that insures longer life, minimizes maintenance.

ALIGNMENT CONSTRUCTION METHOD . . . Components are centered in a common bore, easier to disassemble and reassemble for routine maintenance; no complicated re-alignment is required.

If a bonus in performance can help your present projects, send for more detailed information about CECO Pumps . . . and about completely integrated CECO Fuel Pumping and Control Systems. Ask for your copy of "Engineered For The High And The Mighty . . ."



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PUMPS • SERVOMECHANISMS • CARBURETORS • PROTEK-PLUGS

HOW Faultless AIRMASTER CASTERS ARE SERVING AVIATION

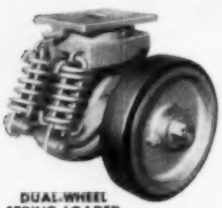
DOUGLAS AIRCRAFT COMPANY, TULSA, SOLVES DIFFICULT MATERIALS HANDLING PROBLEM FOR INSTRUMENTS

Two swivel and two rigid Faultless Spring Action Casters with puncture-proof, pneumatic wheels permit a jolt-free ride for delicate testing units like this one. Easily moved and swiveled, this "Flowrator" is taken over rough areas, with SH332-12x3 (swivel) and SH732-12x3 (rigid) Shock Absorbing Casters smoothing the ride.

Series SH300 Casters absorb impact shocks through use of large durable springs under constant compression. Double ball bearing swivel construction. Hardened balls and raceways.

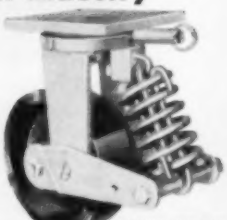
In the gigantic plant of Douglas Aircraft Company, Tulsa Division, many tough materials handling problems are solved with specially constructed castered dollies. For example, highly delicate equipment is used to test installations in the planes. A way was needed to transport this test equipment over rough ground without jarring the instruments. Douglas Tool Engineers designed the Flowrator, mobile test unit, mounted on Faultless Double Action Spring Casters. Sensitive test equipment thus is moved speedily and safely over uneven floors and terrain—inside and out-of-doors. Production costs are cut at testing locations because readjustment of the gauges is unnecessary. Equipment arrives ready for immediate use. To get the complete story on the Douglas caster application mentioned above, simply call your local Faultless Caster Distributor listed in your phone directory, or write us today.

Two of many AIRMASTER Casters produced for the Aviation Industry



DUAL-WHEEL SPRING LOADED

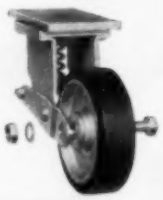
Made in accordance with Military Specifications and approved for use. Write for free illustrations and specification data.



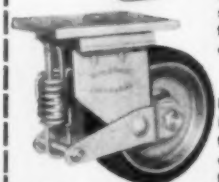
SPRING ACTION POSITION LOCK ON SWIVEL

3 FEATURES EXCLUSIVE WITH AIRMASTER CASTERS

● **Shock-Absorbing Spring Action *parallel to the center line of King Bolt* to balance the load and allow wheel to be in contact with floor at all times, regardless of rough floors or bumpy terrain. Spring assembly is an interchangeable member.**



● **Caster wheels of standard design are *easily interchangeable with stock wheels* to minimize maintenance and "down" time.**



● **Spring Action Caster *continues to function as conventional Caster* in case overload exceeds maximum spring load rating. An important safety factor to load and operators.**

IMPORTANT: A skillful combination of these design features enabled Faultless Swivel and Rigid Types Double Action Spring Casters to successfully *pass all* of the endurance tests conducted by materials handling experts, while all other types of shock absorbing casters failed at one construction point or another. Further facts gladly furnished, no obligation.

FAULTLESS CASTER CORPORATION

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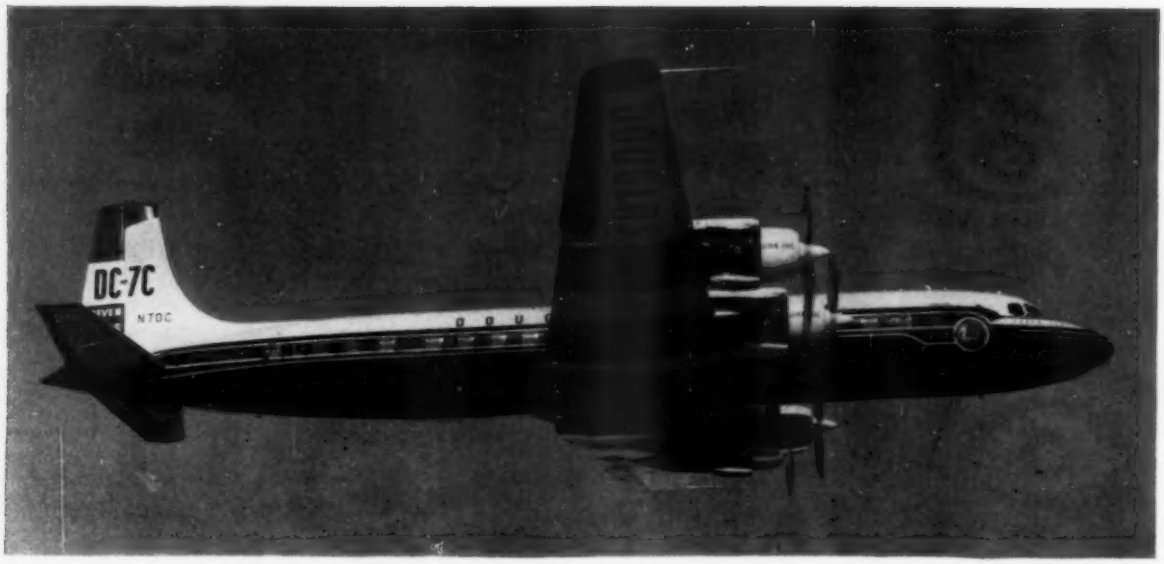
U. S. Aircraft Engaged in Air Transportation

SCHEDULED AIR CARRIER, DOMESTIC SERVICE

Cert. No.	OPERATOR	Douglas						Viscount	Lockheed					Martin		Boeing	Convair		Total
		DC-7	DC-8	DC-6A	DC-6B	DC-4	DC-3	744	1049	749	649	049	18	4-0-4	2-0-2	377	340	240	
105	Alleghany Airlines						14								4				18
25	American Airlines	25	50	3	25	9												74	186
604	Bonanza Air Lines						5												5
18	Braniff Airways		9				23										25		57
21	Capital Airlines					24	21	8				12							65
404	Central Airlines						9												9
23	Colonial Airlines					5	8												13
14	Continental Airlines				3		21										6		30
26	Delta Airlines	11	7				16										20		54
10	Eastern Air Lines	†12			2	9			*27	19				60					129
501	Frontier Airlines						12												12
306	Lake Central Airlines						7												7
104	Mohawk Airlines						10											4	14
16	National Airlines	4	4		8								9				12		37
303	North Central Airlines						18												18
15	Northeast Airlines						11											6	17
20	Northwest Airlines			5	1	17	7		14							10			47
308	Ozark Airlines						14												14
208	Piedmont Airlines						17												17
209	Southern Airways						12												12
601	Southwest Airways						10								4				14
401	Trans-Texas Airways						16												16
17	TWA. (Domestic)					11			†30	39		32		40	11				163
11	United Air Lines	25	12		29	19	13										55		174
702	West Coast Airlines						13												13
28	Western Airlines				8	6	8											9	31
	Trunk & Feeder TOTAL	77	112	8	79	100	285	8	61	58	0	44	9	100	19	10	118	93	1,17

Cert. No.		Douglas							Viscount	Lockheed					Martin		Boeing	Convair	Curtiss	Helicopter				Total
		DC-7	DC-6	DC6A	DC6B	DC-4	DC-3	DC2	744	1049	749	649	049	18	4-0-4	202	377	340 240	C-46	S-51	S-55	47D	47G	
	HELICOPTERS																							
304	Helicopter Air Service																						6	6
603	Los Angeles Airways																			2	5			7
107	New York Airways																				5		1	6
	"CARGO ONLY"																							
203	Aerovias Sud Americana																		6					6
605	Flying Tiger Line			4		4													18					26
212	Riddle Airlines																		16					16
606	Slick Airways, Inc.			3		3													17					23
201	U. S. Airlines																		0					0
	INTRASTATE*																							
6-4	(C) California Cent. Airl						3																	3
6-6	(C) Friedkin Aeronautics, Inc.					2	1																	3
FW-8	Capitol Airways, Inc.						4																	4
	Helicopters, "Cargo Only" & Intrastate TOTAL	0	0	7	0	9	8	0	0	0	0	0	0	0	0	0	0	0	57	2	10	0	7	100
	Acft. Listed on Trunk & Feeder Certs	77	112	8	70	100	285	0	8	61	58	0	44	9	100	19	10	118	93	0	0	0	0	0	1,172
	Acft. Listed on Helicopters, "Cargo Only," & Intrastate Certs	0	0	7	0	9	8	0	0	0	0	0	0	0	0	0	0	0	57	2	10	0	7	100
	Acft. Listed on all Domestic Certificates	77	112	15	70	109	293	0	8	61	58	0	44	9	100	19	10	118	93	57	2	10	0	7	1,272

* Includes 16 L-1049C † Includes 24 L-1049G (4 NWA; 20 TWA) ‡ DC-7B



DOUGLAS DC-7C

Flag Airlines Strengthen Leadership in

The nation's international airlines took their first steps into the jet age in 1955. The move was made in a year of general airline prosperity, a year which showed marked improvement in the carriers' subsidy position, as well as substantial increases in traffic and revenues.

U. S. flag airlines laid the groundwork for coming jet operations with orders for Boeing and Douglas turbojet transports, which will begin serving international passengers in 1959.

Business was good in 1955, although profits were disappointing. Traffic increased considerably, with revenue passenger-miles up more than 18% to 4.43 billion. Cargo business was up 11%, U. S. mail ton-miles up 45% and foreign mail up 6%.

Total revenue for the international carriers increased only 7.7% to $387 million, in spite of a 15% increase in passenger revenue which reached $293 million.

Subsidy payments fell off 73% from $28.5 million to $7.6 million.

Because of these sharp reductions in subsidy, profits did not keep up with the high business level maintained by the carriers in 1955.

DOUGLAS DC-8

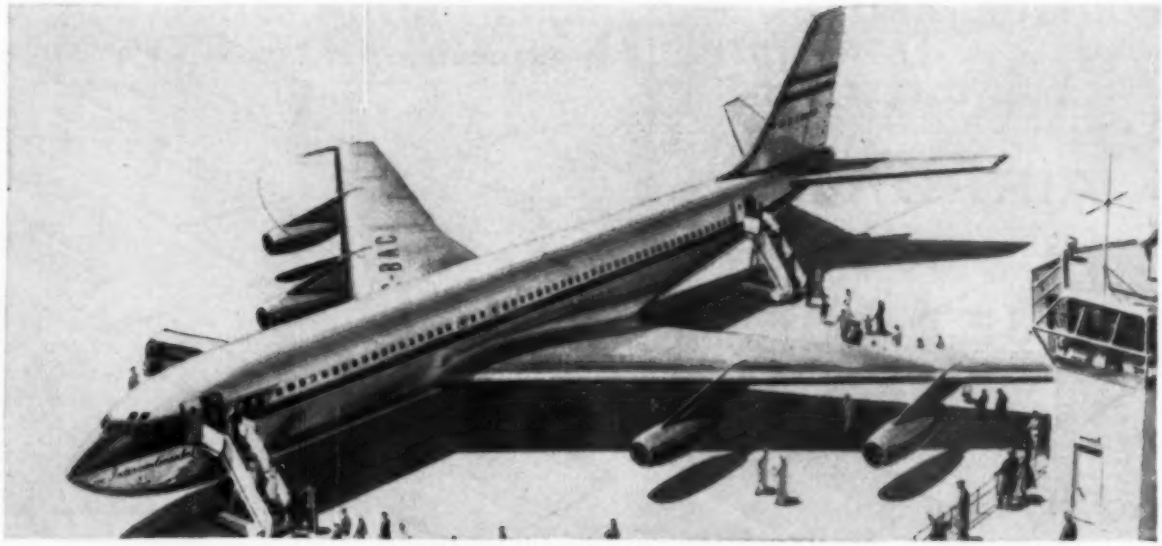
Nearly all the major international airlines have made their initial commitment for turbojet transports. Pan American World Airways made the first move last October when it ordered a mixed fleet of 25 Douglas DC-8s and 20 Boeing 707s. Pan American will be the first airline to get a jet transport, with delivery of the first Boeing 707 promised for December, 1958.

Braniff Airways and Trans World Airlines have chosen the Boeing and Delta Air Lines and Pan American-Grace Airways will operate the DC-8. Northwest Airlines will be the last major international carrier to make up its mind.

Trunk airlines which operate stub-end overseas routes—American Airlines, United Air Lines, Eastern Air Lines, National Airlines—have also committed themselves for turbojet equipment.

The needs of the long routes operated by the overseas airlines have evolved larger, heavier aircraft than specified in the original Boeing and Douglas designs. As range has reached the 5,000-mile class and weight approached 300,000 lb., the DC-8 and the 707 have moved into a class completely by themselves.

The British Comet, the only other turbojet transport which is a current prospect for overseas airline use, is far short of the capabilities of the two American transports. While the British are starting the development of the Bristol Britannia long-range turboprop trans-



BOEING INTERCONTINENTAL

Ocean Traffic

port, it is evident that the bulk of international jet travel will be done on the DC-8 and the 707 ordered by the American carriers. Major foreign airlines are also lining up for delivery of either the Douglas or Boeing turboject.

U. S. Lines Dominate

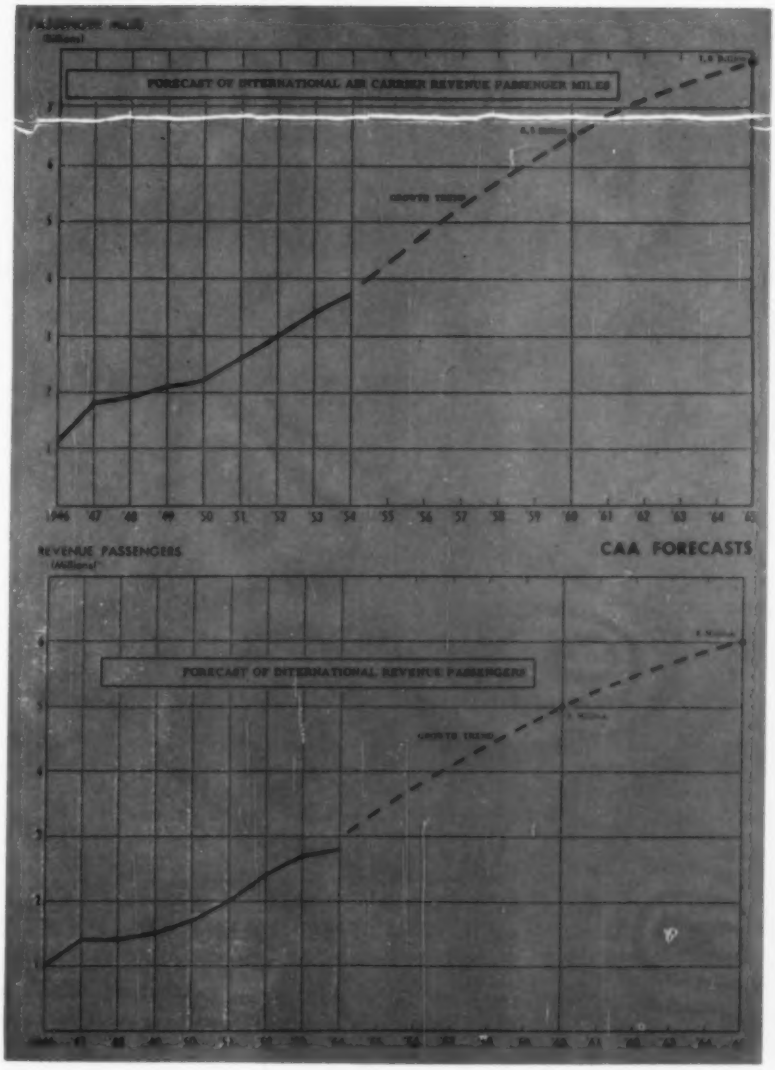
In international travel, the airlines have increased their domination of total traffic, and the American flag carriers have increased their share of total air traffic.

During the year ending June 30, 1955, 65% of the passengers traveling to and from the United States went by air. Passengers arriving by air increased 17% over the comparable 1954 period while sea arrivals increased only 9%. Air departures were up 22% in the 1955 period while sea departures lost 2%.

Travel to Europe makes up about two-thirds of the total sea traffic and about one-third of air traffic. Travel to Bermuda and the West Indies makes up about 45% of air travel from the United States.

The trend to air travel across the Atlantic has made substantial gains. Last June was the first summer month in which more people flew to Europe than traveled by ship.

In the 1955 period, 1,177,546 people arrived in the United States by air, 808,999 on U.S. airlines and 368,547 by foreign airlines. In the same period 1,028,264 people left this country, 698,523 by U.S. flag airline and 329,741



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United States Aircraft Engaged in Air Transportation

SCHEDULED AIR CARRIER, INTERNATIONAL SERVICE

Cert. No.	OPERATOR	Douglas						Lockheed						Martin	Boeing	Convair		Curtiss	Miscellaneous			Total
		DC-7	DC-6	DC-6A	DC-6B	DC-4	DC-3	1C49	749	649	049	18	SC	4-0-4	377	340	240	C-46	G-44	G-21A	Misc.[1]	
802	Alaska Airlines					2	3											***2				7
804	Alaska Coastal Airlines												1							9	2	12
25	American Airlines	*25	*50	*3	*25	*9											*74					186
402F	Braniff Airways		*9																			9
32	Caribbean Atl. Airlines						4															4
102F	Colonial Airlines					*5	*8															13
808	Cordova Airlines						2												1			3
202F	Delta Air Lines	*11	*7				*16									*20						54
201F	Eastern Airlines	*12			*2	*6		*27	*19													66
805	Ellis Airlines																			7		7
5	Hawaiian Airlines						10									5						15
1001F	Mackey Air Transport						4															4
1002F	Midet Aviation Corp.						1															1
203F	National Airlines	*4	*4		*8							*9				*12						37
803	Northern Cons. Airlines						3															3
301F	Northwest Airlines			*5	*4	*17		*4							*10							40
801	Pacific Northern Airlines					2	4			3												9
8	Panagra	5[2]				5	2	5														17
1	PAWA-AD		4	3(e)	44(e)	21(b)					5(a)				(c)							77
4&6	PAWA-LAD			(e)	(e)	(b)	4				(a)				10(c)		5					19
2&3	PAWA-PAD				4	5					(a)				16 (Cert.3)							25
807	Reeve Aleutian Airways						3														1	4
211	Resort Air Lines																	**7				7
901	Trans Pacific Airlines						6															6
34	TWA (International)					*2			*27(d)													29
302F	United Air Lines	*7	*6																			13
806	Wien Alaska Airlines						2											3				5
	TOTAL	64	80	11	92	71	75	31	46	3	5	9	1	0	36	37	79	12	1	16	3	672

*Also listed on Domestic Certificate
**Operated in accordance with Provisions Special CAR No. SR-373A.
***Operated in accordance with CAR No. SR-388A.
[1]Includes 1, CH300; 1, PBY and 1, S-43.
[2]DC-7B.

(a) Listed on Certificates 1 and 3.
(b) DC-4s shown on Certificate 1 are also operated on Cert. 6.
(c) B-377s shown on Certificate 6 are listed on 1.
(d) 12 additional L-749s shown on Domestic Cert. No. 17.
(e) Same aircraft listed on Certificates 1 & 6.

by foreign carrier. These figures, prepared by the U.S. Immigration and Naturalization Service, show American carriers gained 21.2% in arriving traffic and 24.3% in departing traffic over the 1954 period while foreign airlines gained 8.9% and 15.9% respectively.

During the year ending June 30, 1955, 60% of the air passengers bound for Europe chose U. S. airlines, while 21% traveled on British, French and Dutch carriers. Nearly all the traffic to Africa and 85% of the Asian traffic went on American carriers. On South American routes, two-thirds of the traffic went on U. S. airlines, with Colombian and Venezuelan carriers getting most of the rest.

During the summer of 1955, these trends continued. Although foreign airlines appear to have narrowed the gap slightly, the American carriers still outgained them.

Coach traffic continued to increase last year to the point where coach passengers outnumber first-class travelers about two to one on overseas routes, especially over the North Atlantic. The conversion to coach configuration solved some of the pressing capacity problems of the airlines last year, as did introduction of the DC-7B by Pan American and the Super-G Constellation by TWA and Northwest.

Civil Aeronautics Board didn't make any major changes in the international route structure last year. The biggest case decided was the Transpacific Renewal case. After some fumbling, the White House renewed Northwest and Pan American's routes across the Pacific, but put off a decision on whether PAA should be allowed to fly the great circle route to the Orient. Pan American is extremely anxious to get rid of its mid-Pacific restriction and operate over the great circle route now flown by Northwest.

Now, the President has shifted the issue back to the CAB and new hearings will be held to bring the record up to date. Then it will be up to the President again.

In another renewal case, the White House agreed with the Board that Pacific Northern Airlines and Alaska Airlines' certificates should be renewed. The CAB and the White House also agreed that the two carriers should be encouraged to merge. Northwest Airlines' temporary Alaskan authority was made permanent in the case, and the carrier's inner route from Minneapolis-St. Paul was renewed for three more years.

Balboa Decision

After years of travel between the White House and CAB, the Balboa case was finally decided last spring. In the decision, Eastern and Braniff were authorized to operate one interchange between New York and South America, and Pan American, National and

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Panagra were approved for the other. After some haggling among the carriers, the interchanges got under way last summer.

Trans World Airlines' stub-end London-Frankfurt route was hooked up with the rest of the carrier's system by the CAB. The link was made by granting a new route between Frankfurt and Zurich, but the service is subject to negotiation with Great Britain for fifth freedom rights at London.

The New York-Mexico City case still awaits an examiner's report.

Proceedings to establish transpolar services similar to the successful Scandinavian Airlines System operation are currently under way at the CAB. Several carriers want to join SAS and Canadian Pacific Airlines in flying the arctic route to Europe from the West Coast.

During the year, the CAB acted to set new service mail rates for carriers in transpacific, transatlantic and Latin American operations. The new rates were lower than previous permanent and temporary rates.

The Board also cut subsidies for the international airlines, notably Pan American. Latest subsidy estimates show that transpacific operations are free of subsidy, and transatlantic operations require $2.5 million, compared with $16 million five years ago. The subsidy rate for Latin American operations is half the Fiscal 1954 rate.

Bilateral Disputes

Negotiation of bilateral air agreements between the United States and various other nations caused considerable dispute last year. Meetings were held between representatives of the U. S. and Great Britain last spring which settled on routes over the arctic route to Europe and between New York and Nassau, but left unsettled several other important issues.

The greatest disturbance was caused by the conclusion of negotiations with West Germany. When the American carriers learned of the routes awarded the Germans, they protested, and the issue wound up the subject of Senate hearings which are still unfinished.

After a re-examination of the agreement, the CAB and the State Department decided to go ahead and sign it. The main objection of U. S. carriers was to operating rights beyond New York to the Caribbean and Latin America granted to a German carrier. In return, TWA and Pan American got substantial traffic rights in Germany.

A bilateral air agreement was signed with India last month after several years of negotiation.

As a result of the agreement, TWA and Pan American will continue to be restricted to two flights a week each through India with a single stop on each flight.

United specifies Skydrol for entire new jet fleet

In one of the largest commercial jet orders ever placed with one manufacturer, United Air Lines recently purchased thirty Douglas DC-8s for delivery starting in 1959. To help assure maximum operating safety and efficiency for these jets, United specified a fire-resistant Skydrol fluid *for the hydraulic system* (Skydrol 500).

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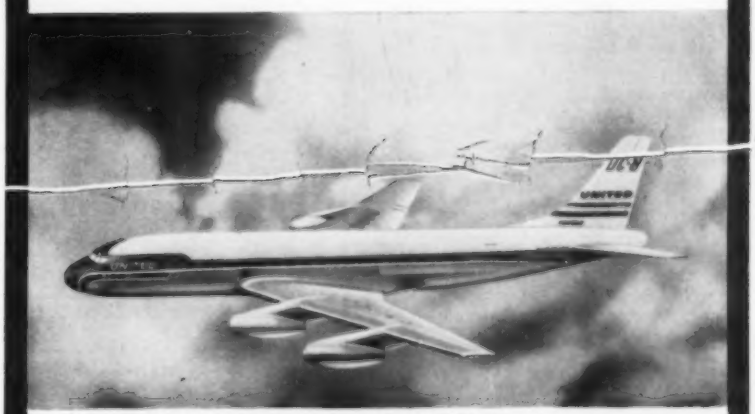

THE DOUGLAS DC-8, powered by four P&W *J-57* engines, will carry 112-140 passengers and 7000 lbs. of freight over 3000 miles non-stop at speeds up to *575* m.p.h. Seat-mile costs of operating these jets may even be less than latest piston types.

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● AIR TRANSPORT

Permanent Routes Back Feeder Growth

By Katherine Johnsen

The local service airline industry promises to continue the fastest growth in air transportation over the next five years—filling gaps in its nationwide network, extending services into major cities, and offering manufacturers a potential market for new aircraft of more than $100 million.

Since the industry was launched immediately after World War II, the biggest milestone in its history was the award last winter of permanent certificates to its 13 carriers by the Civil Aeronautics Board, as directed by Congress in legislation which had overwhelming support from both Republicans and Democrats.

Growth Picture

This is the industry's growth picture:

• **The number of revenue** passengers more than tripled over the five year period from 1950 to 1955. The industry expectation is that it will triple again over the next five years, approaching 10 million in 1960.

• **Similarly, the revenue** passenger mileage more than tripled over the past five years, and is expected to approach 1 billion in 1960.

• **Passenger revenues** increased more than four times, and total commercial revenues by more than three times in 1955, over 1950.

• **Federal subsidy** increased by 61% in 1955 over 1950, due to the growth of the industry. But there was a slight decline, from $22 million in 1954 to an estimated figure of approximately $20 million in 1955.

• **The percentage** of revenue coming from Government subsidy has dropped sharply. Subsidy accounted for 57% of total revenue in 1950, 44% in 1954, and was down to an estimated 35.7% in 1955.

• **Passenger revenues** accounted for only 36% of total revenue in 1950. This increased to 49.8% in 1954 and to 57.5% in 1955.

Reasons for Confidence

There are numerous reasons for industry confidence and estimates of continued rapid growth for the foreseeable future.

Some of these are:

• **The market is there.** Only 10% of inter-city common-carrier travel up to 250 miles moves by air. In this natural field for development by the local service lines, 30% of the travel at present is by bus and 60% by rail—a total of 90% which local air service may challenge.

In the range from 250 to 500 miles,

Growth of Local Service Airline Industry

	OPERATIONS		REVENUE (In Thousands)			
	Revenue Passengers	Revenue Passenger-Miles (In Thousands)	Passenger	Total Commercial	Federal Subsidy	Total
1950	840,899	160,425	$8,067	$9,583	$12,718	$22,301
1954	2,260,024	417,208	25,112	28,161	22,254	50,415
1955	2,963,936	537,017	32,930	36,814	20,478	57,292
Percentage Increase						
1955 over 1950	253%	235%	308%	284%	61%	157%
1955 over 1954	31%	29%	31%	31%	−8%	14%

Local Service Airline Revenues—1955

(1950 figures in parenthesis)

(In Thousands)

	Passenger	Total Commercial	Federal Subsidy	Total
Allegheny	$3,685 (1,291)	$3,984 (1,423)	$1,621 (1,511)	$5,605 (2,934)
Bonanza	1,370 (262)	1,538 (287)	879 (509)	2,417 (796)
Central	876 (74)	1,032 (202)	2,117 (518)	3,149 (720)
Frontier	2,491 (643)	2,970 (810)	2,544 (1,311)	5,514 (2,121)
Lake Central	1,068 (119)	1,238 (324)	1,370 (394)	2,608 (718)
Mohawk	3,391 (584)	3,642 (649)	576 (543)	4,218 (1,192)
North Central	4,910 (427)	5,329 (511)	1,467 (1,295)	6,796 (1,806)
Ozark	2,295 (35)	2,643 (49)	1,724 (111)	4,367 (160)
Piedmont	4,331 (1,531)	4,719 (1,673)	1,661 (1,432)	6,380 (3,105)
Southern	1,664 (361)	1,921 (515)	1,654 (1,248)	3,575 (1,763)
Southwest	2,790 (1,140)	3,286 (1,312)	966 (902)	4,252 (2,214)
Trans Texas	2,120 (675)	2,434 (799)	2,437 (1,698)	4,871 (2,497)
West Coast	1,939 (925)	2,078 (1,029)	1,462 (1,246)	3,540 (2,275)

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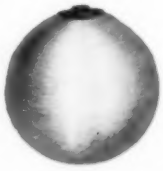

1300
cubic inches

only 25% of the travel is now by air.

One example of the success of local service in meeting the competition of slower but cheaper rail service and trunk service, which have the disadvantage of infrequent schedules, is the Milwaukee-Chicago operation of North Central Airlines. It increased from three schedules a week in 1953 to 41 schedules now. The North Central fare is $14.80 roundtrip. This is in competition with the $11.30 fare of American Airlines, the $12.90 fare of Northwest Airlines, and the $7.60 first class and $4.24 coach fare by rail. The North Central trip is 40 minutes, compared to 75 minutes by rail.

• **The strong trend** toward trunk lines dropping small and medium points on their systems will open opportunities for local lines to move in. Two carriers —Eastern Air Lines and United Air Lines—have bucked this trend, but the local service industry anticipates that circumstances will force them to go along with it. Two key factors are the bigger and faster aircraft with which the trunks are replacing their fleets, and Civil Aeronautics Board's decisions increasing trunk competition between major points. Stops involve time, as well as expense. Trunks are expected to concentrate increasingly on shortening the time with non-stop service between the biggest traffic centers—New York, Chicago, Detroit, Los Angeles, and so on. This, the local lines feel, will also open the way for them to channel the traffic from smaller points into the major cities.

• **There are still** a few gaps in the local service network to be filled. In Florida, the development of local service has been discouraged by Eastern, making stops at a number of small cities to pick up New York traffic. Stiff competition for New York-Miami business is expected to induce Eastern to drop these.

Western Expansion

Local service lines are now ready to expand service into the Wisconsin-North Dakota-South Dakota-Nebraska-Iowa area and the Montana area. Proceedings are now pending before CAB.

This leaves only two gaps in the local service network: the New England area, in which small towns are serviced extensively by Northeast Airlines; and the Eastern Nevada-Western Utah desert area, which does not yet promise sufficient traffic.

Nevertheless, the industry has numerous inter-related problems on its way to growth, improved service and financial position.

The goal is to be subsidy-free, and there is and will continue to be steady pressure by CAB to accomplish this.

But the outlook is that, during an intermediate period of five years in which the local carriers will be expanding and financing replacement of their outmoded DC-3 fleets with an economical aircraft, subsidies will have to continue at the present level or increase. The industry has a strong ally in the congressmen, Republicans and Democrats, who put development of the local systems first and subsidy reduction second.

The two major aims of the local service carriers in 1956 are to improve their financial position and move forward with fleet replacements.

Financial Position

The industry hopes for a change in CAB policies on cost allowances and profits to improve its weak financial position. It is also backing legislation authorizing airlines to retain earnings on the sale of aircraft "for a reasonable time" for re-investment in new equipment, without having the earnings considered as revenue offsetting subsidy requirements. In recent decisions, CAB has used equipment sales income to offset subsidy.

Proof of the fallacy of CAB's policies, according to John Floberg, counsel of the Conference of Local Service Airlines, is the fact that "after 10 years of progress, growth and service we have an industry without an earnings record, with no credit standing, and with negligible capitalization." None of the local carriers has ever declared a dividend. The earned surplus of the whole industry is approximately minus $500,000.

Points Floberg makes in support of more favorable CAB treatment for the industry are:

• **The profit** of the local lines is "ridiculously low" on volume of service. It is running about one-half of 1% of sales after taxes.

This compares with 5.7% for the trunk lines, 5.4% for the international carriers and 10.2% for the helicopter operators.

"The local carriers will receive for 1955 approximately the same total net profit as the three helicopter operators, but they will have to do 15 times as much work to earn it," Floberg said.

He argues that the performance improvement of the local lines has been even more creditable than the trunks, but that the Board has not given this consideration. While the trunk carriers have increased revenue passenger mileage about 20% over 1954 and raised the load factor from 60 to 62%, the local lines increased passenger mileage by 30% and raised load factor from 35 to 43%. "The reward to the trunks for their excellent work has been a fitting 100% increase in net profit," Floberg said. "The reward to the locals for their performance has

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been a paradoxical 55% reduction in their net profit."

• **An 8% profit** allowance on investment is "ridiculously small" for local service lines since the capital, surplus, and long-term debt of the whole industry is only $15 million.

Basing profits on investment, he maintains, is applicable to public utilities, which have about $4 of invested capital to each dollar of revenue. It is not applicable, he said, to the local service lines, with about 25 cents investment per dollar of revenue.

If the CAB does use invested capital as a yardstick for industry profits, it should follow the policies of the Renegotiation Board, which allow in excess of 100% profits on invested capital for industries with similar ratio of investment to volume of business, Floberg maintains.

• **The cost allowances** of the Board are unrealistic. Floberg objects that the Board uses "the composite perfect carrier" as the norm in judging each individual carrier. For example, it gives no special consideration to a carrier operating in severe winter conditions —having to operate engines all night, so they will start in the morning; the extra expense of running planes in snowy and icy fields; special ground heaters for cabins; preflight de-icing of aircraft, and increased hangar heating cost.

CAB Policy Complaints

Other CAB cost allowance policies that are handicapping and discouraging the industry, Floberg said, are:

• **The Board** "disallows longevity pay allowances almost as automatically as the collective bargaining agreements of the carriers require them."

• **Executive salary** ceilings are "absurdly low, with the anomalous result that a pilot may be paid more than a fairly senior executive."

• **The $12,000 annual** ceiling on legal fees is "scarcely enough to provide for routine corporate work, participation in labor negotiations, and other legal work typical of retainer arrangements; the cost of litigations, including mail rate cases and route cases should also be allowed."

Successor to the DC-3

A high estimate is that there will be a market for 500 DC-3 replacements in the domestic market by 1960. At a unit price of $400,000 this would amount to a $200 million market; at a $500,000 unit price, $250 million.

A more conservative estimate is a demand for 375—or a $150 million market at a $400,000 unit price, or $187.5 million at a $500,000 unit price.

These estimates give account to two variables: that the successor to the DC-3 will have greater capacity and efficiency

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and replace one and a half to two DC-3s, and that the volume of business of the local service industry will triple—or better—in the next five years.

There are now 150 DC-3s in local airline service (plus eight Martin 2-0-2s and three Convair 240s). In addition, there are approximately 100 DC-3s in domestic trunk services which require replacement.

Complete replacement of the total 250-plane fleet of DC-3s would require an estimated 125 to 167 new planes of greater capacity to handle the volume of business. If the volume of business is tripled or quadrupled, as the industry expects, over the next five years, this requirement for DC-3 replacements would mount to 375 to 500.

Fokker F-27 Favored

The Fokker F-27—on which Fairchild Engine and Airplane Co. has the U.S. manufacturing rights—has the lead as a successor to the uneconomic and obsolescent DC-3.

The 36-passenger capacity—which may be stretched to 40 passengers—and the 200 mph. performance of the F-27 compares with the 24-passenger capacity and 145 mph. performance of the DC-3. Fairchild is reportedly ready to launch production with the receipt of 50 orders, at a unit price of $540,000. One local line, West Coast Airlines, has placed an option for six, and several other local lines are likely to follow suit.

A large segment of the industry, though, is interested in inducing other U.S. manufacturers to design a DC-3 replacement around the turboprop engines of General Electric Co. or the Lycoming Division of Avco—both later developments than the Rolls-Royce turboprop of the F-27.

Also, the industry is pushing for a unit price from $400,000 to $500,000.

The industry plans to advocate legislation to encourage the development of an alternative to the F-27, either by providing Government guarantees on purchase price or Government-guaranteed loans for purchases, or granting outright Government financing of 50% of the development cost.

A few companies have indicated an interest in moving into the short-haul transport field—North American Aviation, Inc., Douglas Aircraft Co., Inc., Chance Vought Aircraft, Inc., Temco Aircraft Corp.

Local airline leaders think that U.S. manufacturers are letting Fokker walk off with a prize market by default. In addition to a demand for about 500 short-haul aircraft domestically within the next five years, Floberg points out that "there will be a demand for hundreds more in the development of air transportation in South America, Asia and Africa.

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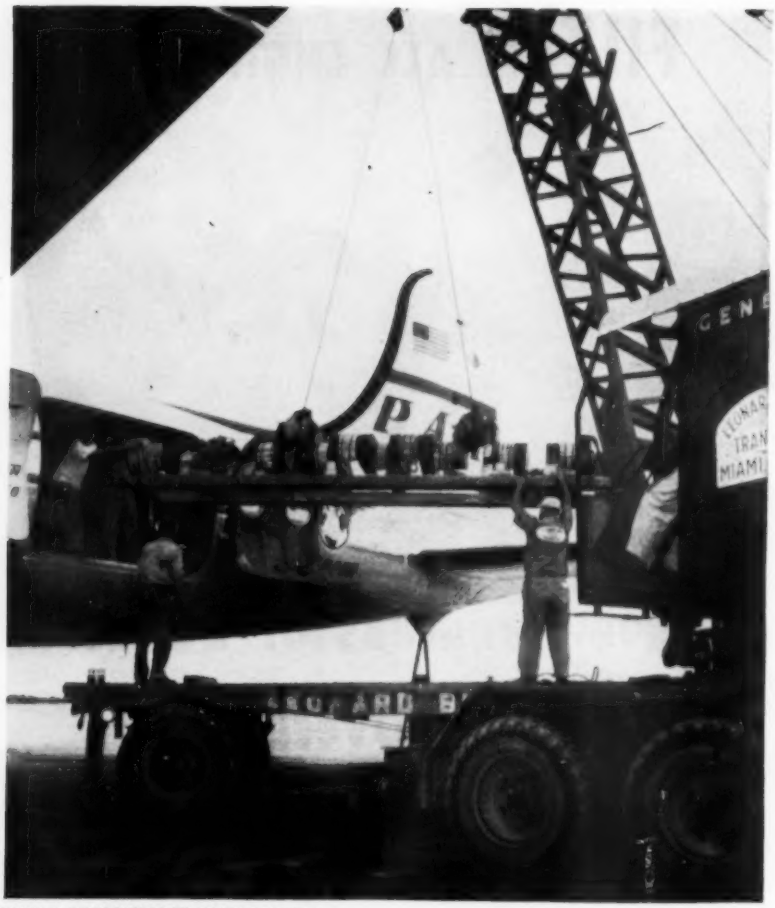


GIANT CRANKSHAFT GOES BY AIR

DC-6A—MOST MODERN PLANE IN TODAY'S CARGO FLEET

Air Cargo

By Preble Staver

The air cargo industry took a sharp upturn in 1955 with the prospects bright for an even better year in 1956.

The industry's air mail, air express, and air freight operations showed a substantial breakthrough last year, after a rather disappointing 1954.

Domestic air cargo volume in 1955 rose to over 500 million ton-miles of all types of traffic, a gain of more than 30% over the preceding year. The 1954 operations were at approximately the 1953 level, which in turn represented a gain of only 5% over the year before.

Air freight represented the bulk of the traffic with 381 million ton-miles flown; air mail amounted to 86 million ton-miles; and air express totaled 50 million ton-miles.

Industry spokesmen predict these figures will nearly double in the next 10 years. Major reason for the anticipated expansion is the prospect of more economical cargo aircraft and improved ground handling methods. Both developments will have the effect of reducing operating costs, thereby allowing rate reductions which will, in turn, encourage more volume.

The 1955 air cargo fleet primarily consisted of the Curtiss C-46, Douglas DC-4 and the Douglas DC-6A. The scheduled passenger airlines, of course, carried considerable cargo in all types of combination passenger-cargo aircraft.

The scheduled airlines dominated the U. S. domestic air cargo business again in the past year. However, both the certificated all-cargo lines and large irregular air carriers are beginning to take a larger share of the market.

The advantage to the passenger airlines in using combination passenger-cargo aircraft has been one of cost consideration and the availability of capacity, but it appears that the proportion is declining as volume increases.

The three-way fight for the air freight traffic has never been an even split. The scheduled lines' share for the first time slipped below 50% in 1955. They took 46% of the traffic.

Division of the air freight market among the three classes of operators for 1954 and 1955 was as follows:

	1954	1955
Passenger Airlines	50.8%	46.1%
All-cargo Airlines	28.4	31.1
Large Irregulars	20.7	22.8
	100%	100%

Air cargo, and more specifically air freight, has yet to measure up to the

Booming, Looks Ahead to Better Planes

great potential that has been forecast for it since the end of World War II.

Nevertheless, the experts' rosy promises of a tremendous future begin to look better than the record would indicate in the last several years. The reasons for the optimistic outlook:

- **Record high traffic** figures in 1955.
- **Favorable actions** by the Civil Aeronautics Board.
- **Predictions of a higher** national level of economic activity in 1956 than in 1955.

Air Cargo—1955

Here is how air cargo traffic shaped up in 1955:

- **Domestic trunk carriers** flew a total of 311,581,793 ton-miles, a gain of 18% over 1954 and nearly equaling the 19% gain in passenger-miles flown. A breakdown of the cargo traffic shows 175,929,346 ton-miles of air freight, an increase of 21.9%; 86,067,617 ton-miles of air mail, up 7.3%; and 49,584,830 ton-miles of air express, a gain of 23.7%.
- **All-cargo carriers** had a 43.5% gain in traffic. Four companies—Aerovias Sud Americana, Flying Tiger Line, Riddle Airlines and Slick Airways—handled a total of 118,219,756 ton-miles of air freight last year as against 82,300,043 ton-miles in 1954. Flying Tigers gained a phenomenal 80% in revenue traffic while Slick was up 35%. These two transcontinental air freight lines together shared 25% of the total market, with 49,822,572 ton-miles for FTL and 47,461,228 ton-miles for Slick.

Riddle flew about 14.5 million ton-miles, including both domestic and internationl operations, while Aerovias Sud operated 6.5 million ton-miles out of St. Petersburg, Fla., to and from Central America. The all-cargo lines, excluding Aerovias Sud, carried mail for the first time in 1955, totaling 246,554 ton-miles.

- **Local-service carriers** flew approximately 4 million ton-miles of air cargo, including 1.3 million ton-miles of air freight, 1.4 million ton-miles of air express, and 1.2 million ton-miles of air mail. This compares with a 3-million ton-mile total figure in 1954.
- **U. S. international carriers'** cargo operations included 93.5 million ton-miles of air freight and express and another 59.5 million ton-miles of U. S. and foreign air mail for gains of 12% and 14%, respectively.
- **Irregular air carriers** divided their cargo operations almost half-and-half last year between commercial and military traffic. They flew 45.5 million ton-miles commercially and 42.5 ton-miles for the military. The year showed a total gain for the group of 31 million ton-miles of air freight over 1954, with 90% of the increase coming from new commercial business.

The scheduled passenger airlines—trunks, local service and international—continue to maintain a strong interest in all forms of air cargo as additional sources of revenue. In the case of the trunk airlines, it should be noted, that revenue from all types of cargo traffic still represents less than 10% of the total.

Lion's Share

It is the Big Four of the scheduled lines (American, United, TWA and Eastern) that, nevertheless, receive the lion's share of the traffic and revenues in the air cargo market. These carriers not only operate their regular combination passenger-cargo schedules but also have scheduled all-cargo services as well.

The Big Four grossed $35 million on air freight alone in 1955, or about $10 million over the preceding year. The closest challengers were Flying Tigers and Slick whose combined gross exceeded $21 million.

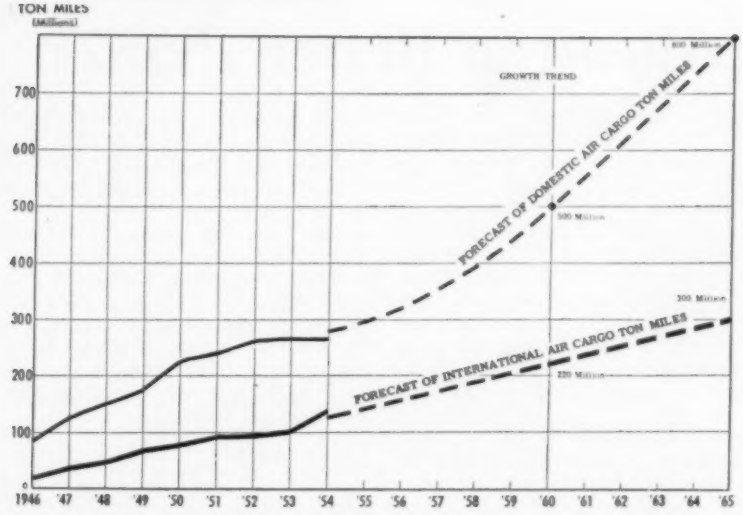
Thus, the leadership of the scheduled airlines in the air freight field has been

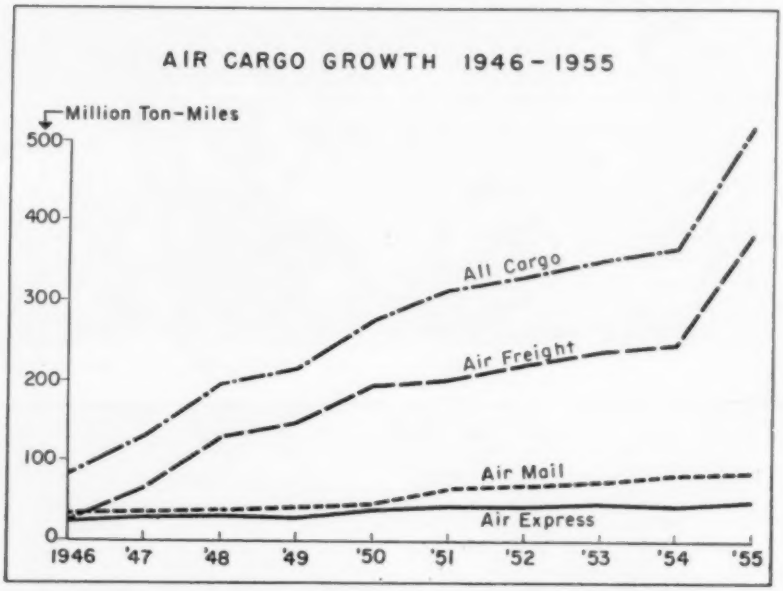
Air Cargo: 1955—1954

	TON-MILES					
	MAIL		EXPRESS		FREIGHT	
	1955	1954	1955	1954	1955	1954
TRUNKLINES						
American	18,101,987	16,472,408	11,083,333	8,590,732	67,030,262	53,956,820
United	25,103,908	22,660,145	12,791,971	10,470,771	39,553,351	33,610,388
TWA	12,964,881	14,696,793	8,407,014	6,901,969	24,423,863	21,309,523
Eastern	10,063,637	8,625,230	5,584,454	4,318,072	14,006,219	10,350,460
Delta	3,299,168	3,405,257	2,697,462	2,465,247	6,614,630	5,738,914
Northwest	4,521,522	3,394,416	2,655,006	1,898,395	6,581,930	4,469,091
National	3,138,812	2,871,734	708,703	631,873	4,262,543	4,468,553
Others	8,873,702	8,050,017	5,656,887	4,812,941	13,456,547	10,336,251
	86,067,617	80,176,000	49,584,830	40,090,000	175,929,346	144,240,000
CARGO LINES						
Aerovias Sud	.....	.....	.....	.....	6,561,148	5,152,942
Flying Tiger	60,868	.....	.....	.....	49,882,572	27,413,051
Riddle	35,665	.....	.....	.....	14,314,808	14,850,792
Slick	150,021	.....	.....	.....	47,461,228	34,883,258
	246,554	.....	.....	.....	118,219,756	82,300,043
Large Irregular Air Carriers	.....	.....	.....	.....	87,166,627	56,893,217

Source—CAB Reports.

Cargo Forecasts by CAA





challenged, and seriously challenged. Although American Airlines maintained its leading position, grossing $15 million on 67,030,262 revenue ton-miles, Flying Tigers and Slick closed in fast to push United Air Lines from second place in 1954 to fourth last year.

CAB Actions

Flying Tigers and Slick, with transcontinental routes, quite naturally dominate the all-cargo group, a group whose number was increased to five near the end of the year. CAB in late November granted American Air Export & Import Co., a Miami-based non-certificated cargo carrier, a five-year certificate for all-cargo operations.

At the same time that AAXICO won its route award for service between New York, Chicago, Detroit and New Orleans, CAB also granted Riddle Airlines a five-year certificate for cargo services between Boston, New York, Detroit and Chicago and Miami. (Riddle previously operated over a similar route under exemption as an irregular air carrier.)

Furthermore, both East Coast carriers were granted the right to carry air express, for which service begins in 1956, but authority to carry air mail was deferred for a decision to include both Flying Tigers and Slick.

Both FTL and Slick appeared to have won their certificate renewals at the end of 1955. Of the four original carriers awarded five-year temporary all-cargo certificates by CAB in August 1949, they are the only ones to survive. They have each been recommended by a CAB examiner for seven-year renewals plus the authority to carry air mail and air express. Full CAB endorsement is expected and a final decision is anticipated this spring.

A green light means the four domestic all-cargo lines will have equal competitive rights with the scheduled passenger carriers for all classes of air cargo traffic.

Slick's Outlook

CAB's action will most certainly be a needed shot in the arm for both FTL and Slick. The latter suffered the most when a plan to merge with FTL fell through in late 1954. Although Slick increased its ton-miles from 34 million to 47 million in 1955, the carrier nevertheless suffered a half-million-dollar net loss. Operating expenses climbed twice as fast as the jump of $4 million in gross revenues, resulting in the year's loss (compared to $1 million net profit in 1954).

Delos W. Rentzel, Slick's president, sees only an upward trend for the future. The new fleet of five Douglas DC-6As will make a big difference, he says. The all-cargo plane's direct operating cost of about 6¼ cents a ton-mile compares with about 12 cents a ton-mile for the three C-54s and 17 C-46s also operated by Slick. A full fleet of the more modern aircraft should permit a cut of 10% to 20% in the present average ton-mile rate of 18 cents, Rentzel believes.

Slick also intends to place important emphasis on the use of trucks in connection with air service as an extension of through service to many communities where it's not economical to operate aircraft.

According to Rentzel it is economical to operate trucks within a range of 200 to 300 miles from major terminal airports. He said inauguration by Slick of the combined air-truck service is now scheduled for Apr. 1.

Rentzel says Slick is still looking for the "right" all-cargo airplane and "we're keeping our eye on the Lockheed C-130," a turboprop transport now in production for the Air Force. He indicated that in two or three years, the C-130 should become available to commercial cargo carriers. This might make it possible to lower air freight rates as much as 50% when the low-cost C-130 is ready for full-scale operation, he said.

Atlantic Cargo

Two other segments of the air freight industry stand to benefit in the future from CAB decisions of last year. The Board issued the first transatlantic all-cargo certificate. It also established new and very liberal operating rules and regulations for indirect air carriers—air freight forwarders.

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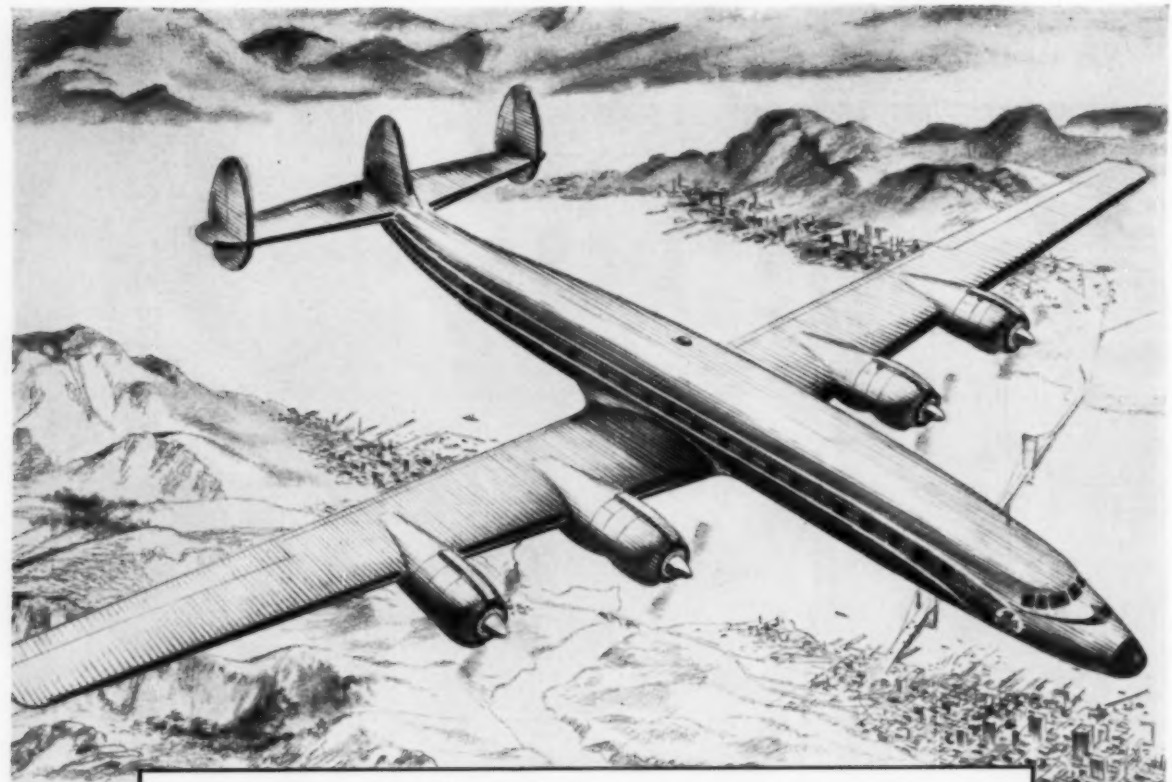

Stainless airframe assemblies by Solar for the Lockheed 1649

DIFFICULT NEW DEMANDS to improve performance led Lockheed to specify stainless steel nacelles and other airframe assemblies for the new long-range 1649 Super Constellation. As the leader in fabricating hard-to-work metals for almost three decades, Solar was selected for this exacting work.

Solar will build 44 different assemblies for the giant 1649 covering the structure from the powerplant firewall back over and under the plane's wing. By using stainless steel, critical areas of the aircraft will gain greater strength without adding weight. This new airframe program recognizes Solar's pioneering achievement in building stainless steel nacelles in volume for Navy P2V patrol planes.

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pioneer transatlantic all-cargo carrier, won its bid for a certificate with a five-year temporary authorization. Seaboard's victory in the eight-year-old Transatlantic Cargo Case was spurred by the inauguration of scheduled intercontinental air freight service by the British firm, Airwork, earlier in the year (Airwork abandoned its services, however, after less than a year of operations as the only scheduled all-cargo carrier over the Atlantic).

Seaboard has yet to implement its certificate but is hopeful of beginning scheduled transatlantic all-cargo operations later this year. The carrier, of course, operated throughout the year as an irregular carrier overseas as well as participating in military airlift contracts. The company reported a 33% increase in transatlantic operations with a record total of 5,127,300 lb. of air-freight moved. In addition, S&W hauled another 3,721,932 lb. of air freight for the military, making its total carriage of air cargo 67% greater than in 1954.

During the last half of 1955, Seaboard ordered five Lockheed Super Constellation 1049Hs as part of a fleet expansion program.

Freight Forwarders Boosted

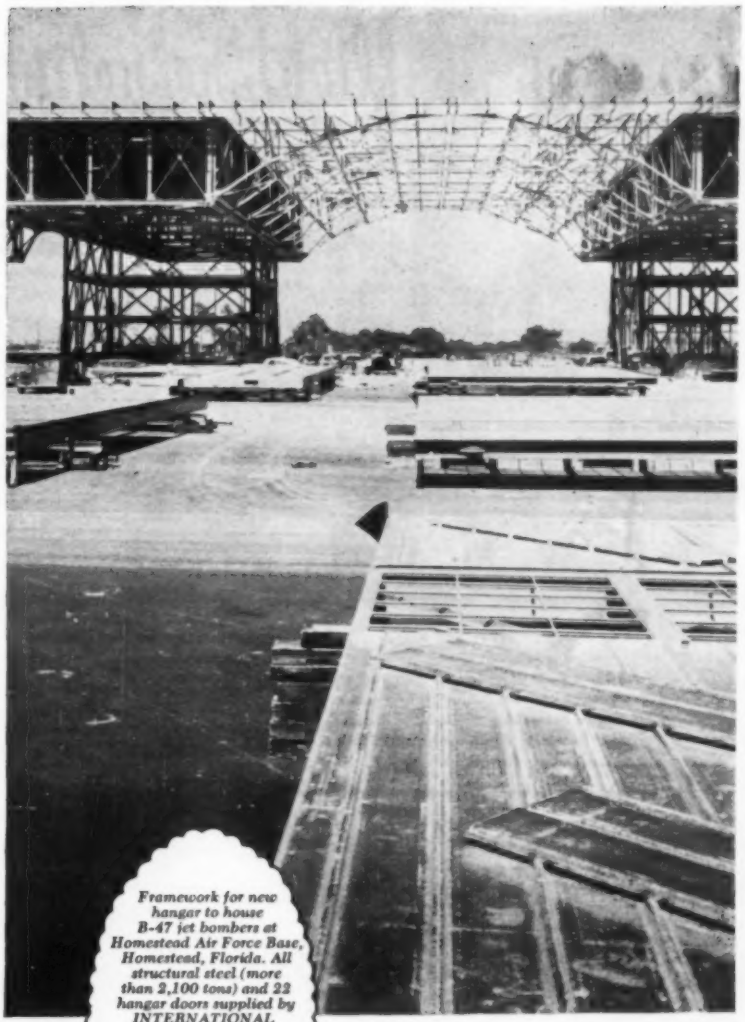
The air freight forwarders got a big boost last year from CAB's new, definitive set of regulations, plus the extension of operating authority for 34 companies for an indefinite period.

The new regulations are oriented toward competition within the developing industry. CAB recognized the forwarders as a potent force in the future development of air freight for the airlines. The air freight forwarder is visualized as another salesman in a field badly needing vigorous sales activity.

As phenomenal as the growth of air freight has been, its development is no easy matter to be explained away by the natural expansion of a postwar economy. Many obstacles were overcome in the first 10 years of air freight history. The industry's growth in the last decade can be attributed primarily to:

- **Increased selling effort** on the part of the air carriers.
- **Certification** of the all-cargo carriers by CAB.
- **Expansion** of all-cargo service to additional routes and communities.
- **Efforts** of the air freight forwarders to secure new business.
- **Improvement in ground handling,** pick-up and delivery service, packaging and crating techniques.
- **Increased dependability** of air freight operations.

These same factors point the way toward even greater expansion in the future.



Framework for new hangar to house B-47 jet bombers at Homestead Air Force Base, Homestead, Florida. All structural steel (more than 2,100 tons) and 22 hangar doors supplied by INTERNATIONAL SERVICE.

lots of wing room needed in a "B hive" like this

OVER 81,000 SQUARE FEET, in fact, is the amount of unobstructed floor space required — to accommodate the huge B-47 jet bombers housed in this giant hangar. To provide this vast wide-open area called for more than 2,100 tons of structural steel, much of it specially fabricated to assure adequate supporting strength. Despite this extra-heavy tonnage, International Service spanned the distance to keep construction on schedule . . . supplying all structural steel and all hangar doors as well. Write for your copy of the International Steel Facilities Guide.

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A-12 Hose Reel Unit—several hundred gallons per minute rate. Qualification test reports have been submitted to WADC. Standard U. S. Navy equipment, modification available for wing-tip mounting.

A-1 Nozzle, A-3 Coupling used in receiving aircraft and in drogue tanker respectively. In use with U. S. Navy refueling system.

MA-2 Nozzle for receiver aircraft and Coupling, mounted in drogue unit, with higher rate of flow. Qualification test reports have been submitted to WADC.

The Probe and Drogue refueling system, developed and manufactured by Flight Refueling, Inc., has been used extensively by the United States Navy. This system employs the A-12 hose reel unit, the A-1 nozzle, A-3 coupling, and drogue unit. In addition, Flight Refueling, Inc., has submitted qualification test reports to the USAF for an improved A-12 type refueling unit for multi-point tanker installation, and likewise for a refueling unit of even higher capacity. These units are already in production and will shortly go into service in aircraft of the Tactical Air Command.

Flight Refueling's engineering department is working closely with many leading aircraft manufacturers to assist them in developing new refueling systems, today's universal requirement to give modern jets extended range and load-carrying capacity. If you would like more information on Flight Refueling, Inc.'s equipment or facilities, just drop a note to Contracts Administration Department.

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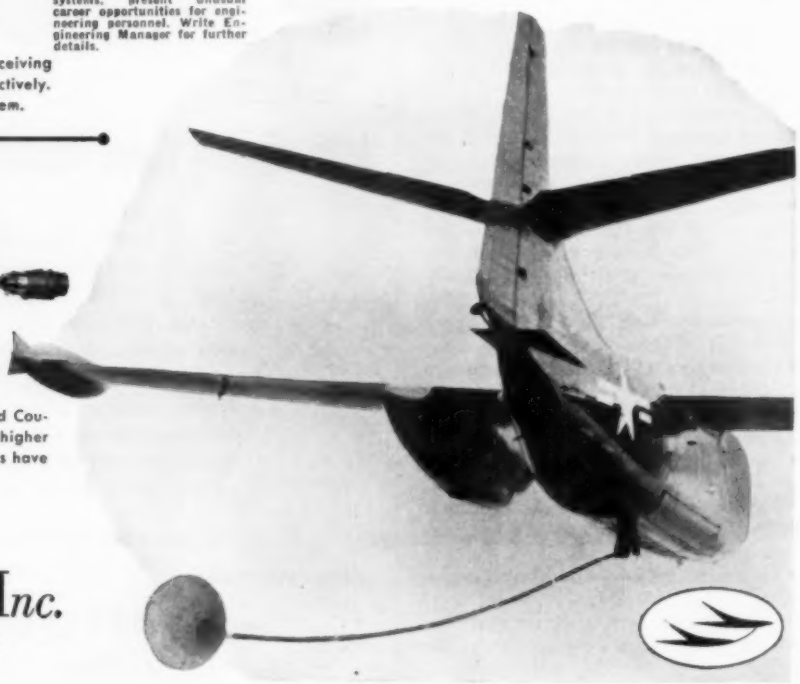

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FRIENDSHIP INTERNATIONAL AIRPORT
Baltimore 3, Maryland

Supplemental Carriers See Bright Future Under New 'Ground Rules'

The year 1955 marked the beginning of a whole new future for the nation's non-scheduled airlines.

After 10 tempestuous years, with their legal status in doubt, the irregular operators now have not only a firm status but a fixed policy to back it up.

The Civil Aeronautics Board ruled, after four years of investigation, that non-scheduled operations do have an important role to play in the national air transportation system. The Board's decision was not final until the last day of the year.

When CAB made its ruling, only 49 companies had survived out of the more than 100 original operators. As part of the new picture, CAB's first step was to rename the "nonskeds" as Supplemental Air Carriers. Next, the Board drew a sharp line of authority for them and established a clear set of rules for their operations.

New 'Ground Rules'

The new class of air carriers is visualized by CAB as providing types of service the regular airlines either cannot or do not want to provide. In addition, they will be available to take the overflow of traffic the scheduled carriers can't handle at peak traffic periods.

The rules governing Supplemental Air Carrier operations provide for:

- **Unlimited domestic passenger** and cargo charter operations.
- **Maximum of 10 scheduled** flights a month in one direction between any pair of points for individually ticketed passengers or waybilled cargo service.
- **International charter authority** for cargo operations only.

Until CAB has examined the merits and qualifications of each of the 49 applicants as a Supplemental Air Carrier, all of them are presently operating under a blanket exemption order.

The Board made one exception in the case and excluded four of the five carriers of the North American Airlines group from the exemption. Furthermore, as the "fitness and ability" proceedings progress the Board will undoubtedly cut the ranks more, leaving about 30 active companies.

A corollary Board decision of tremendous importance to the Supplemental carriers was the approval of air charter clearing house operations by the two industry associations—Aircoach Transport Assn. and Independent Military Air Transport Assn. This decision permits ACTA and IMATA to operate air exchanges for an experimental period of three years.

Supplemental Carriers

These are the Supplemental Air Carriers designated by CAB as eligible for new operating authority, effective Jan. 1, 1956. The new class of carriers were renamed from non-scheduled airlines in the Board's decision of the Large Irregular Investigation, Docket 5132.

Aero Finance Corp.
Air Cargo Express.
Air Services, Inc.
Airline Transport Carriers.
All American Airways.
American Flyers Airline Corp.
Arctic-Pacific, Inc.
Argonaut Airways Corp.
Arnold Air Service.
Associated Air Transport.
Aviation Corp. of Seattle.
Blatz Airlines.
California Air Charter.
Capitol Airways.
Caribbean American Lines.
Central Air Transport.
Coastal Cargo Co.
Conner Air Lines.
Continental Charters.
Currey Air Transport.
Economy Airways.
General Airways.
Great Lakes Airlines.
Johnson Flying Service.
Los Angeles Air Service.
Meteor Air Transport.
Miami Airline.
Modern Air Transport.
Monarch Air Service.
Overseas National Airways.
Quaker City Airways.
Paul Mantz Air Services.
Peninsular Air Transport.
Regina Cargo Airlines.
Royal Air Service.
Sourdough Air Transport.
Southern Air Transport.
Standard Airways.
Stewart Air Service.
S. S. W., Inc.
Trans-Alaskan Airlines.
Trans-Caribbean Airways.
Transocean Air Lines.
The Unit Export Co.
U. S. Aircoach.
U. S. Overseas Airlines.
World Airways.
World Wide Air Lines.

The Supplemental carriers hailed both decisions. They feel that at last there will be enough stability and that there is sufficient market potential for them to conduct a really profitable operation for the first time. They are particularly hopeful that the fact they're

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When a part previously of steel or aluminum is being redesigned for magnesium, the moment of inertia must be increased in proportion to the lower elastic modulus of magnesium to obtain the same stiffness. But – the moment of inertia increases as the cube of the thickness of the beam. So—very little added thickness tremendously increases stiffness. The net result is a slightly thicker section for the magnesium part, and a marked reduction in weight.

This is why magnesium is used for floor beams in airplanes; for radar feed horns and reflectors where low inertia and high stiffness are required; and for hundreds of other similar applications.

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The men in the field listen to "battle instructions" over tiny receiver units built inside their helmets.

With a range of about a quarter mile, the RCA Transceiver can be pre-set for any frequency between 45 and 52 mcs. Only two controls are used and no tuning or adjustment is necessary during normal use. The receiver is an all-transistorized superheterodyne and the transmitter comprises two transistors and one tube, both contained in a single unit.

The feather-lightness and miniature size of the transceiver and receiver make it possible, for the first time, to extend communication to the individual level. It is another instance of RCA's constant search for new and better ways of doing things electronically. Demonstration and consultation with RCA field engineers throughout the world are invited. Call or write.

RCA Ultra-Miniature FM Transceiver compared with AN/PRC-10 (Walkie-Talkie)

TYPICAL MILITARY APPLICATIONS

- Tactical communications between squad and platoon leaders and higher, also with individual soldier or marine
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here to stay will make it easier to arrange financing, allowing them to buy new equipment and modernize.

It is also expected that the new service authorizations will give the Supplementals a better balance between commercial and military traffic. Over 50% of the traffic in recent years has been dependent upon the military. The carriers recognize the need, as did the Board, for a better balance of traffic.

Despite the peaks and valleys common to military traffic, which has its adverse effects, recent Defense Department policies hold out encouragement for the Supplementals. The most important development is that the military now believes air transportation should be used as a matter of routine and that civil aviation should build an airlift reserve.

The Supplementals see themselves in an improved position to provide additional reserve requirements. To do so, however, means meeting the military's demand for pressurized equipment. This again points up the Supplementals' pressing need for more, and more modern, equipment.

Commercial Air Exchange

A fleet of 116 aircraft was operating in 1955. ACTA member carriers had 59 aircraft available, of which there were 26 DC-4s, three DC-6s, 18 C-46s and 12 DC-3s. The IMATA members, excluding the certificated all-cargo operators, also had 59 aircraft—20 DC-4s, one DC-6, 27 C-46s and 11 DC-3s.

Both organizations operated military traffic exchanges and both are in the process of expanding facilities to handle commercial traffic through air exchanges.

Under the air exchange principle, the associations will now act as agents for commercial plane-load charters as they had been doing for military Civil Air Movements (CAMs).

A virtually virgin market exists for the commercial exchange inasmuch as civil air charter had been undeveloped heretofore.

The operating picture of the Supplemental Air Carriers in 1955 was considerably improved over that of the preceding year. The group as a whole flew 1.5 billion passenger-miles in the year, a 19% increase over 1954. The gain approximated the increase enjoyed by the domestic trunklines, although the volume represented less than 8% of the 20 billion passenger-miles flown by the trunk airlines.

The number of passengers carried by the Supplementals in 1955 increased to 820,000, for a decided gain over the 690,000 handled the year before. Cargo traffic also improved, with the ton-miles flown up from 56,893,217 in 1954 to 87,166,627 last year.

It should be noted, however, that in 1954 the Supplementals had suffered sharp reverses from 1953 in all categories of traffic, with revenues and profits dropping correspondingly.

Operating revenues took an upturn in 1955, reaching $71,806,138. Operating expenses also climbed, to a total of $70,117,989.

There also was a decided shift away from the dominance of military traffic during the year—770,602,000 passenger-miles were flown commercially, exceeding the 687,356,000 passenger-miles operated for the military. The same was true in cargo operations, with 45,455,897 ton-miles flown in commercial service and 41,710,730 ton-miles in military traffic.

The North American Airlines group, which has consisted of five individual operating companies for several years, was still the biggest factor in common carriage "non-scheduled" operations. North American flew some 500 million passenger-miles and handled nearly 275,000 passengers, which was one-third of the nonsked total in mileage flown and better than 25% of the total passengers.

The future of the North American group is still unsettled. A final decision, which will be made in the courts, is expected by mid-year.

Royal
AMPHIBIAN NEWS

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ROYAL GULL TO SERVE AS EXECUTIVE TRANSPORT FOR DEVLIEG MACHINE CO.

Ferndale, Michigan—Charles DeVlieg, Sr., president of the DeVlieg Machine Co., announced recent purchase of a new Royal Gull. The twin-engine, five place amphibian will be used in two capacities. It will serve as an executive transport for the sales force and it will also be used for high speed reply to calls for service.

In purchasing the Royal Gull, Mr. DeVlieg (at controls) reported, that the company spent more than five months studying all types of executive aircraft available which might best answer all business travel needs. No ship met the "test" as well as the unusually versatile "go anywhere" Gull.

Fully equipped for instrument flight, the Gull has a range of almost 1000 miles. It's powered by twin 270-hp Lycoming engines. Top speed is 182 mph and cruising speed is 164 mph. Two-engine service ceiling is 18,500 ft. and single-engine ceiling is 5000 ft.

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Jet Orders Speed Airport Obsolescence

The planning, design and development of airports enters a new era in 1956—an era brought on by the approaching use of commercial jet transports.

What effect will these aircraft have on the nation's airports?

What changes in fueling, ground handling, loading and unloading of passengers and cargo will they require?

What runway lengths and strengths and taxiway specifications will be needed?

These are only a few of the unanswered questions which airport operators, airlines and jet aircraft builders have begun to face up to in the past year.

Problem Is Immediate

A turning point in airport thinking already had been reached in 1955, even before the problems to be posed by jets were considered. The conclusion is inescapable that airports in the U.S. today are inadequate—both in numbers and facilities—to handle even the current demands of air transportation.

In all dynamic activities, obsolescence is one of the greatest handicaps. This is especially true of airports. As U.S. air traffic broke all growth records in 1955, the situation again reached a point requiring a review of airport improvement programs. Aircraft volume is exceeding airport capacity and in some areas is reaching the crisis stage.

The approaching "jet age" points up that technological advances in aircraft development have consistently been ahead of airport planning and development. The DC-3 airports were not adequate for the DC-7s and Super Constellations. And the DC-7 airports will not be adequate for the jet airliners.

The airport builder is thus confronted with a three-fold problem. There must be provision for adequate runway length for the higher speeds of newer designs, adequate strength for ever-increasing weights, and better obstruction clearance in the surrounding areas for increased safety. A major requirement is the wherewithal. Financing has been a tremendous problem.

Assist From Government

A big assist toward meeting present and future airport needs, money-wise, was initiated by the federal government last year. A new, four-year building program enacted by Congress authorized a total of $252 million on a local matching fund basis. This more than doubles the amount of airport construction funds previously available.

At the same time, the Civil Aeronautics Administration, which is responsible for running the Federal Airport-Aid Program (FAAP), revised its policies and procedures. CAA liberalized the program significantly by making three basic changes in the type of airport facilities eligible to receive federal aid. Matched federal funds, for airport construction are now available as follows:

- **On the basis** of the actual or potential need of the community.
- **To use in building** all types of airport terminal buildings.
- **To provide automobile** parking areas required to serve airport users.

More Federal Aid Due

Federal aid grants by CAA for the current fiscal year have totaled $62.5 million, covering more than 500 airport improvement projects. Before July 1, CAA is expected to allot another $63 million for airport improvement and expansion programs during the fiscal year 1957, which will be equalled with matching amounts of local money. It is interesting to note that one-third of the 1955 grants-in-aid made provision for acquisition of land or easements to protect airport approaches, as recommended in the Doolittle Commisison report.

It is expected that increased federal aid will halt the downward trend in the number of active civil airports. During 1955 there were 6,850 active civil airports—177 less than were in operation the year before. Congress finally over-rode the Eisenhower Administration's opposition to airport-aid money on the theory that an adequate network of airports is of national concern.

Airports play a major part in the welfare and security of the country. Since the national interest includes airport location, uniformity of standards, design of construction, and lighting and navigation aids, it is the responsibility of the federal government to help financially in the construction and maintenance of an adequate airport system.

CAA Meets Challenge

Under the Congressional directive, CAA has picked up the challenge. CAA Administrator Charles J. Lowen made the first move when he called for a joint Government-Industry Jet Age Airport Conference in Washington earlier this year. He told the well attended meeting that "CAA's legislative mandate is to foster the development of civil aeronautics and of a national airport system adequate to anticipate and meet the needs of civil aeronautics."

This meeting, the first of a planned

Aircraft Movements: Landings and Takeoffs

1955		Airport	1954	
Ranking	Movements		Ranking	Movements
1	381,737	Chicago-Midway	1	349,363
2	276,729	Miami	3	268,889
3	266,058	New York-LaGuardia	5	236,012
4	263,516	Los Angeles	2	279,630
5	246,709	Atlanta	9	211,674
6	239,861	Denver	6	235,362
7	226,768	Cleveland	7	223,741
8	225,914	Washington, D. C.	12	202,573
9	221,637	Teterboro, N. J.	11	210,256
10	221,419	Phoenix	16	192,527
11	220,478	Dallas	8	215,685
12	212,560	Albuquerque	15	194,944
13	211,085	Long Beach	14	199,363
14	204,498	San Francisco	13	201,209
15	198,464	Louisville	10	210,507
16	198,188	El Paso	17	187,207
17	195,591	Honolulu	4	266,583
18	195,306	Columbus	28	160,524
19	193,568	St. Louis	21	176,098
20	193,478	Oakland	18	179,872
21	182,873	Minneapolis	26	166,388
22	178,012	Birmingham	20	177,354
23	176,689	Kansas City, Kan.	22	174,844
24	176,528	Pittsburgh	24	169,449
25	167,157	Kansas City, Mo.	25	167,449
26	152,226	Knoxville	19	179,297
27	144,690	Detroit-Willow Run	35	128,600
28	144,327	Detroit-Wayne Major	39	121,814
29	143,833	Philadelphia	27	165,149
30	143,633	Boston	37	124,286
31	138,292	New York-Idlewild	38	122,522
32	127,198	Newark	46	108,226

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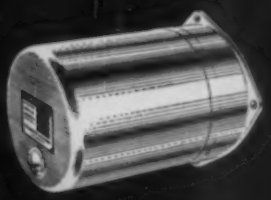

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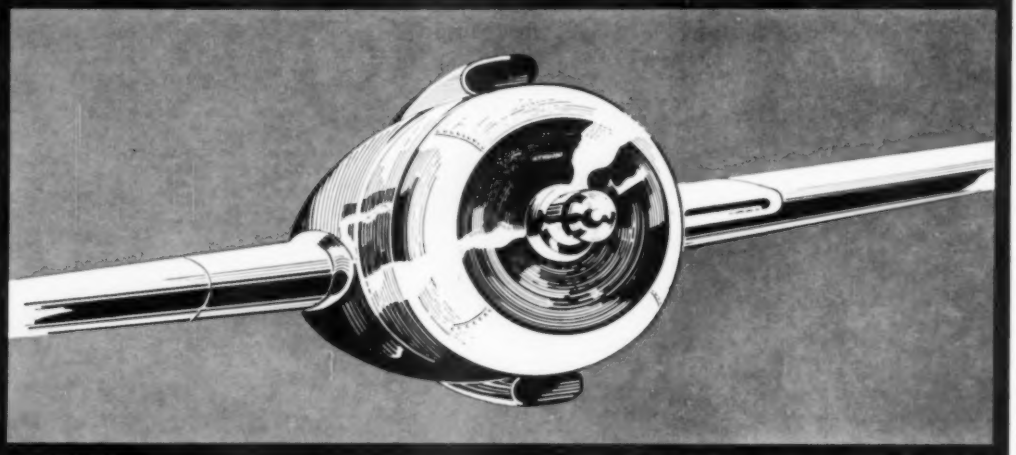

8 out of 15 "Million Miler" safety awards in 1955 went to pilots flying Airwork Overhauled Engines.

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series, provided the opportunity for an exchange of views between all parties and a review of standards for airport planning, both of which were highlighted by talk of the problems of jet operations.

The preliminary discussions on requirements for a trunkline jet airport left unresolved such problems as whether the noise level can be made tolerable and whether runways will have to be made longer and tougher. Terminal facilities also are involved in meeting the jet age requirements.

Among the major problems that will arise in servicing jet aircraft will be refueling. The volume of fuel to be handled per aircraft is so great that additional fire fighting services will be required. Gate positions for jet transports will have to be positioned at the outer end of tiers. Waiting room facilities must be expanded for 150 passengers per aircraft. The airlines also will need either a new form of ticketing and check-in procedure or a minimum of 15 counter positions to handle a single departing jet transport. To highlight the latter problem, Lowen asked: "Do you know any airport in the U. S. that has ticket counter space for 150 or 160 passengers boarding the same flight?"

Airport Operators' Status

The jet age has, for the first time, brought new status to the airport operators from both the airlines and the aircraft builder. To meet and solve the problems now under study requires the coordinated effort and cooperation of all three.

Emerging as a dominant voice for airports' interests is the Airport Operators Council (AOC), which is composed of the operators of 40 of the largest civil airports in the country. These 40 airports handle approximately 75% of the enplaned scheduled domestic passengers and 95% of the international and overseas passengers. AOC is already hard at work to meet and solve the problems airports will face in less than three years, when jet transports begin regular service.

A half-dozen AOC member airports have opened new multi-million dollar terminal buildings and other facilities in the last two years and another six have major projects under construction that will be completed in the next two years.

A look at last year's airport traffic, as reported by CAA, shows not only today's increases but future trends. In 1955 CAA control towers handled 19,600,000 landings and takeoffs, or 10% more than the 17,950,000 reported the year before.

Twenty-five of the leading terminal airports handled more than 30% of the total landings and takeoffs.

CASE HISTORY 1

REQUIRED:
A dependable supply of this small, machined electrode to meet customer's quality and quantity needs at reduced cost.

HASSALL SOLUTION:
Hassall-designed re-heading process, involving no critical dimension changes, resulted in a 59% cost reduction to customer.

CASE HISTORY 106

REQUIRED:
Replacement for stud with insufficient head to act as stop for automatic hammering.

HASSALL SOLUTION:
Substitution of Hassall cold-headed collar nail with annular threads for greater holding power. Substantial cost savings.

SPECIALTY MANUFACTURER OFFERS SAVINGS ON SMALL PARTS AND FASTENERS

CASE HISTORY 64

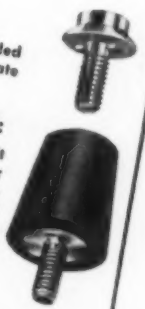
REQUIRED:
An economical method of manufacturing perforating punches out of hard materials such as drill rod.

HASSALL SOLUTION:
The Hassall cold-heading process plus engineering skill overcame the difficulties presented by these alloys at considerable savings.

CASE HISTORY 37

REQUIRED:
Bumper bolt with bonded rubber cap for license plate support.

HASSALL SOLUTION:
The large head on this bolt would ordinarily call for screw machining but the two lugs under the head ruled this out. Progressive cold-heading was Hassall's answer.



Multiply these case histories a thousandfold and you'll get some idea of the variety of tough problems we crack, and the savings we effect for our customers in the course of a year.

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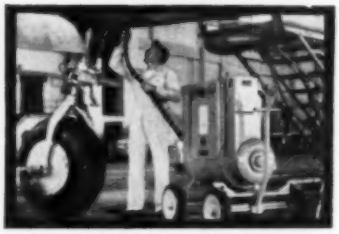
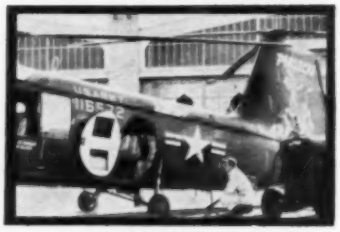


Maintenance and Overhaul



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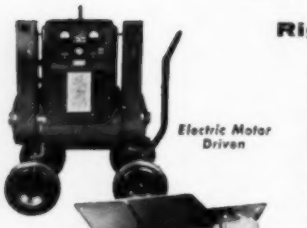

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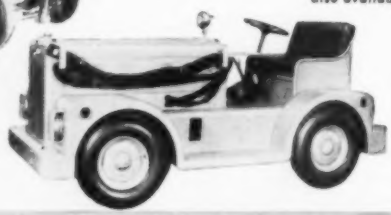

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Air Transport Booms Around-the-World

Air transport boomed worldwide in 1955. Some 69 million passengers were carried more than 38 billion passenger-miles by the scheduled air fleets.

In 18 major countries, exclusive of the United States, gains in passenger traffic ranged as high as 30%, while air cargo totals soared as much as 39% over 1954.

In this bullish air travel market, airlines all over the world were busily planning even greater things in 1956. New services and sales programs were being developed, and most of the carriers were spending millions of dollars to increase their aircraft fleets. Many were well along with plans for the jet era.

Highlights of activities outside the U. S. are summarized below.

Australia

The 12 scheduled air carriers of Australia, a country of nine million people, carried more than two million revenue passengers over 800 million passenger-mi. in 1955. The 1,963,017 domestic passengers in the total of 2,019,132 represent an increase of 8.2% over the previous year. Freight increased 13.1% to 37,733,231 ton-mi. and mail 4.9% to 1,465,197 ton-mi.

Trans Australia Airlines, the leading carrier, handled 684,570 of the passengers, while Australian National Airways was second with 637,154 passengers. A. N. A. introduced Douglas DC-6Bs over some of its routes during the year, and continued to operate DC-6s, DC-4s and DC-3s.

Trans-Australia added Vickers Viscounts to its fleet of DC-4s, Convair 240s and DC-3s. Both airlines are seeking DC-3 replacements.

Qantas, the international operator, now flies Lockheed Super Constellations but is under constant British pressure to switch to United Kingdom equipment. Qantas, however, probably will order American jets, although it probably will also order some Britannias.

Ansett Airways, operating Convair 340s and DC-3s, further consolidated its position as third largest of the domestic carriers. It wants to buy Convair 440s and two Lockheed Electras.

Austria

Austrian aviation activity increased during 1955 as aircraft landings almost trebled to a total of 8,637, air passengers trebled to 129,775, and freight doubled to 1,389 metric tons. Most of this traffic was handled at Vienna's Schwechat Airport.

Two Austrian airlines were founded during the year—the privately organized Air Austria and a government-sponsored airline—but political hassling held up their development. With four Viscounts reported on order from Vickers, Air Austria still lacked an operating permit. The government organization, on the other hand, lacked personnel, funds and equipment.

Belgium

Concentrating on the first-class passenger market, Sabena in 1955 made a comeback from its 1954 operating losses. Its overall load factor increased from 68.2% up to 71.3%. The Belgian airline entered the transatlantic jet race with orders for four Boeing 707-320 Intercontinentals. Sabena also anticipated delivery of nine Douglas DC-7C aircraft for its Brussels-New York and Brussels-Africa runs, and 12 Convair Metropolitans for European service.

Sabena instituted interchange services with Swissair over the Brussels-Paris and Brussels-Geneva routes and will interchange with Swissair and Scandinavian Airlines System using the Metropolitans.

Helicopter services were expanded during the year, and Sebana ordered eight Sikorsky S-58s to replace its six Sikorsky S-55 seven-seaters. Hourly service between Brussels and Paris is planned.

Air credit plan and an air auto plan (drive-yourself-car waiting at destination) were adopted by Sabena in 1955.

Sabena's 1955 traffic statistics: 449,698 revenue passengers, up 14.8% from 1954; 405,000,000 passenger/mi. flown, up 14.5%; 15,500,000 ton/mi. of freight, up 11.7%; 3,250,000 ton/mi. of mail, up 22.9%.

Brazil

Three of Brazil's international airlines experienced an active 1955: Varig, with three new Lockheed Super-G Constellations, opened once-a-week service to New York; Real-Aerovias operated a DC-4 tourist service to Miami and applied for an extension to Chicago; and Panair do Brasil stood to benefit greatly by a subsidy increase voted for overseas carriers. The country's fourth overseas operator, Cruzeiro do Sul, will become a public company in 1956, apparently in a refinancing effort.

Nacional Transportes Aereos, a do-

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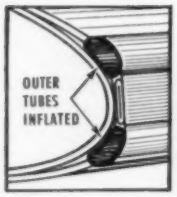
B. F. Goodrich De-Icers have ice hazards than all other



1928 Dr. W. C. Geer and B. F. Goodrich engineers develop world's first ice protection—a rubber "boot" that inflates to crack ice off wing leading edges.

1955 Chordwise pneumatic De-Icers (right) on Lockheed Super Connies have latest design improvements that were developed for larger, faster planes—smaller tubes, electronic controls, quick-snap inflation cycles.

NOW Specification of B. F. Goodrich De-Icers for Boeing's KC-135 jet tanker unveils the newest development in ice protection—metal-clad, electrical De-Icers bonded to the metal leading edges of KC-135 stabilizers. This design-of-the-future is another example of the leadership in research and engineering that has kept B. F. Goodrich first in the fight against ice.

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B. F. Goodrich also makes electrically-heated rubber for any place spot heat is required. If you have any ice protection problem, we're ready to help you. *The B. F. Goodrich Company, Tire & Equipment Division, Aeronautical Sales, Akron, Ohio.*

Pictured above; representative aircraft protected with B. F. Goodrich De-Icers (l. to r.): *Top row:* Douglas mail plane, Northrop Alpha, Douglas DC-1, DC-2, DC-3, Boeing 247, 307, Lockheed 10 Electra. *Second row:* Sikorsky S-43, S-44 Excalibur, Grumman JRF-1, Lockheed Lodestar, Martin PBM-3, Douglas B-23, Martin B-10B, Beech 18. *Third row:* Curtiss C-46, Martin 167, Douglas DC-4, Boeing 314, Lockheed Hudson, Martin B-26, Boeing B-17, Douglas C-54. *Fourth row:* Martin 170 Mars, Avro Lancaster, Douglas A-26, Consolidated B-24, Douglas C-47, Boeing B-29, Chance Vought F-4-U, Douglas AD-4. *Fifth row:* Lockheed RC-121, Martin P5M-1, Boeing C-97, Cessna 310, Lockheed F-94-C, Lockheed 1049-G, Bell 47, Beech C50.

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mestic carrier, in 1955 acquired 23 C-82 cargo aircraft and was expanding its freight services in the interior of Brazil. Another local carrier, Loide Aereo, increased its profits during the year by emphasizing its "misto" service—passengers carried with freight at reduced fares.

Viacao Aerea Sao Paulo (VASP), the other major Brazilian airline, was expected to suffer heavy losses for the year.

Generally, the domestic lines seemed to be having a hard time of it, with decreased load factors apparently due to overcrowded routes. Fares have increased about 90% in the past three years, and there has been some unauthorized fare-cutting.

Under the new subsidy law, payments to users of four-engined pressurized planes will amount to about 20 cents a mile, a tremendous boost to Panair with its heavy mileage across the South Atlantic. The airline has ordered four new DC-7Cs for 1957 delivery.

Real is negotiating for the purchase of four DC-6Bs to provide a first class service, and possibly with an eye on an eventual Tokyo route. Japan Air Lines may begin serving Brazil this year, depending on the outcome of negotiations, and Lufthansa, as well as the Portuguese National Airline, are expected to come in during 1956.

The Brazilian airlines flew 1.1 billion passenger-miles during 1955, compared with 950,000,000 in 1954. Cargo was up 55.3 million ton-mi. from 51.8 million in 1954, while mail dropped to 1.8 million ton-mi. from 1954's total of 2 million ton-mi.

Total subsidy rose from $1.2 million in 1954 to $2.3 million in 1955, and was expected to reach $2.5 million in 1956.

Canada

Trans-Canada Air Lines opened the first North American turboprop service in April of 1955 with Vickers Viscounts on its Montreal-Toronto-Winnipeg route, and has since extended the Viscount operation over its transcontinental and U. S.-Canada routes. With the help of its Viscounts, TCA increased its passenger traffic 13.4% last year. The airline ordered 10 more to bring its total to 34 Viscounts.

For its transatlantic, West Indian and transcontinental services, TCA expects to order either the Douglas DC-8 or the Boeing 707.

Another new service was inaugurated in 1955 by Canadian Pacific Airlines with polar route flights between Vancouver and Amsterdam, now on a twice weekly schedule using Douglas DC-6Bs. CPA also started flying nonstop between Toronto and Mexico City, acquiring the route in a trade with TCA.

Canada's third airline emerged during the year with Pacific Western Airlines' purchase of two smaller companies. The enlarged carrier's routes now extend from the western Arctic down the Pacific coast.

Airlift operations on the DEW radar line and the mid-Canada radar line stimulated a great expansion of Canada's non-scheduled cargo transport during 1955. From a few air freighters, this charter fleet has grown to more than a dozen four-engined aircraft and over 30 twin-engined planes. Cargo activity by the scheduled carriers also is on the increase, helped by the radar work and a boom in mining.

Canada expects a steady increase in airline business. CPA, which operates for the most part internationally, has ordered four DC-6Bs for 1956 delivery and four more for 1957. Also in 1957, Canadian Pacific expects delivery of three Bristol Britannia aircraft. It has optioned five more.

Other Canadian airlines, some of which are broadening from regional to national structure through mergers, are buying second-hand aircraft for cargo services and smaller planes like the de Havilland Beaver and Otter for freight and passengers.

Finland

Finland's two scheduled airlines flew a total of 1,046,053 passenger-miles during 1955, operating Convair 340s and DC-3s. In addition to these two lines, Finnair (mostly state-owned) and Karhumaki Airways (privately owned), there are about 40 small air companies in Finland, engaged in taxi work, bush flying, and the like.

Finnair opened a Helsinki-Moscow schedule at the end of the year, under its new bilateral agreement with Russia.

France

Until a strike of airport personnel at Orly and Le Bourget seriously interrupted operations from Nov. 10 until the end of 1955, the year's civil air activity in France had been running 10 to 15% above 1954. The strike cut into Air France's European operations, though long-line services were continued from other airports. The private French airline companies—Union Aeromaritime de Transport, Compagnie de Transports Aeriens Intercontinentaux, and Air Algerie—also were affected.

Air France's gross operating revenue for the first 11 months was $126,000,000, indicating a higher year's total than the $132,000,000 in 1954, but higher costs and the strike were on the debit side. In 1954, the carrier lost $1,650,000 after government payments.

During the year Air France added seven 1049G Super Constellations to its fleet. Seven additional Super Con-

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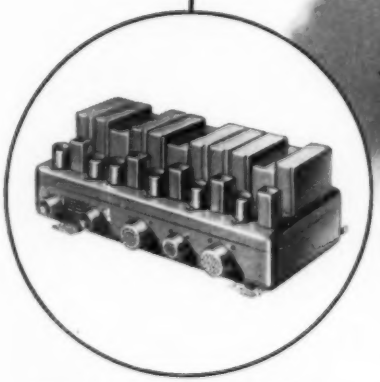

CENTRAL AIR DATA COMPUTER BRAIN OF THE AIRESEARCH SYSTEM

Complete system functions include providing true airspeed, true angle of attack and yaw, relation to Mach number, density and rate altitude, engine pressure ratio, true dynamic and static pressure, cruise control and other factors.

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INDIANA GEAR

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nies are on order from Lockheed. The airline ordered 10 Boeing 707-320 Intercontinental jets, 12 Caravelle medium-range turbojets, and ten 1649 Constellations.

UAT made sharp gains in 1955, increasing its 11-month passenger total 63% to 124,998 passengers. This carrier operates chiefly in French African territories, but also serves Vietnam and South African points. UAT's freight was up 43.5% in 1955.

TAI, which like UAT relies mainly on DC-6Bs and DC-4s, also increased its business by about 10%. Air Algerie's totals were up substantially.

At government direction, Air France and the private airlines concluded a "coordination agreement" which divided up business within the French Union. It was hoped that this would end the cutthroat competition.

Germany

Lufthansa, the revived German national airline, began a domestic service in April, a European service in May, and transatlantic service in June. Lufthansa carried 75,000 passengers, 550 tons of freight and 366 tons of mail.

The German airline's present equipment includes four Convair 340's for its European routes, four Super Constellations for the transatlantic run, and three DC-3s for intra-Germany schedules.

Four Super Constellations are scheduled for 1956 delivery. Lufthansa plans to buy either Douglas or Boeing jets to stay abreast of the competition.

When the new Constellations are delivered, Lufthansa plans to fly 11 weekly round trips across the Atlantic, two via Montreal to Chicago. In addition, a new route to South America and another to the Near East are planned this year.

Load factors on the transatlantic route are now 42%, on the European routes, 60 to 65%.

Great Britain

Britain's two nationalized airlines are now able to "stand on their own feet," the Minister of Transport said last month in announcing that subsidy provisions for British Overseas Airways Corporation and British European Airways would end March 31. But, while both airlines' traffic and revenues were up in 1955 and they would end the fiscal year in the black, BOAC appeared a little wobbly on its feet and no British plane was in sight to match the Boeing and Douglas jets.

In addition to the jet enigma, the British airline industry faces other serious problems at the start of what appears to be a critical year. Lack of cooperation between the flag airlines and the Royal Air Force Transport Command has left the home market for British-built transports largely in doubt. BEA faces the continuing problems of short-haul and highly seasonal traffic.

Pressure for greater freedom for independent British airlines, and for a BOAC-BEA merger, further clouds the picture. Charters of both the nationalized carriers expire in 1956 and will be reviewed by Parliament in the face of political criticism

On the bright side are the traffic increases and Britain's strong lead in the turboprop field.

It appeared that BOAC might have to "buy American" and use DC-8s or 707s in the near future to compete fully over the North Atlantic. Britain may try to skip the initial straight jet competition. Handley Page, for example, reportedly has under design a civil jet transport.

BOAC now has 33 Britannias on order, 11 of which are long-range Mk. 310s for transatlantic service.

During 1955 BOAC's revenue passengers increased 22% over 1954 to a total of 344,950. Passenger-miles climbed 12.5% to 989,793,000.

BEA, whose route segments average about 240 miles, carried 2,157,000 revenue passengers in 1955, an increase of 18% over 1954. Passenger-miles went up 24% to 688,311,000.

Popularity of tourist services continues to climb. This traffic made up 45% of BOAC's load, and BOAC expects tourist to exceed first class traffic in 1956 for the first time. BEA, operating 97% tourist.

BOAC's present fleet is a "patchwork" replacement of its Comets now totaling 21, Douglas-designed Argonauts, 16 Boeing Stratocruisers, and 16 Lockheed 749 Constellations. The airline has on order 19 Comet IVs, 10 Douglas DC-7Cs, and 12 Viscounts for associates.

BEA now operates 26 Viscounts, 19 Elizabethans, 28 DC-3s, two Herons, four DH-89A biplanes, three Westland-built S-55 helicopters, two Bristol 171 helicopters and one Bell 47 helicopter. On order are 38 Viscount 800s, 20 Vanguards, one Heron and one Viscount 700.

Holland

KLM Royal Dutch Airlines flew over a billion passenger-miles in 1955, a total of 1,051,000,000 compared with 976,700,000, in 1954. Cargo ton-mi. were 37,192,000, up from 32,266,000, and mail ton-mi. were 6,137,000, up from 6,000,000.

The airline's estimated 1955 revenue was $104,000,000, up from $96,210,000 in 1954.

KLM entered the jet race with an order for eight Douglas DC-8s for 1960

how to make a "Tiger" roar!

TELEFLEX® cable control assures positive throttle action on new Grumman F11F-1

Flashing into supersonic speeds, the pilot of the Navy's new Grumman Tiger jet gets instantaneous response when he gives it the gun. The throttle control that pours on the fuel is provided by a 20-foot Teleflex control linkage.

In designing the F11F-1, Grumman fighter built to pioneer in using the new "area rule," Grumman engineers wanted a throttle control system that would—

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DESIGN ENGINEERS: For detailed engineering data, write to TELEFLEX INCORPORATED, 125 S. Main Street, North Wales 9, Pa., for your copy of Catalog 400.

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delivery. Also on order were three Lockheed 1049 Constellations, nine Vickers Viscounts, 10 Douglas DC-7Cs, and two Fokker F-27s.

India

India's air importance was highlighted during 1955 by its unilateral termination of the Indo-U.S. air agreement of 1946. This reduced Pan American and Trans World frequencies, pending further negotiations and benefited British Overseas Airways Corporation and KLM, since Air India International was insufficiently equipped to take up the slack.

Air India's present fleet includes eight Constellations and Super Constellations and one DC-3C freighter. Three 1049G Super Constellations are on order. It hopes to establish a direct route to Moscow, and extend its Hong Kong route to Peking in Red China during 1956.

The domestic Indian Airlines Corporation, although it continued to lose money in 1955, was buttressed by a Planning Commission appropriation of about $20 million for the next five years. IAC purchased five DC-4s for its night airmail service and put eight new de Havilland Herons on feeder routes.

IAC plans to buy 18 Viscounts and 35 medium-sized aircraft.

Including new aircraft for the two airlines and airport programs, the Indian government plans to spend $70 million during the 1956-1961 period. It has earmarked $45 million for aircraft payments through 1958.

The two airlines last year carried more than half a million passengers.

Israel

El Al Israel Airlines hopes to attract a larger slice of the European tourist trade when its three Bristol Britannias are received in the summer of 1957. It also plans to step up its New York flights to four weekly by this summer.

Two new Constellations will be put in service this year by El Al.

The airline estimates its 1955 traffic at 34,000 revenue passengers, compared with 30,277 in 1954; 700,000 kilos of cargo down from 857,000 in 1954 (the loss being attributed to increased passenger traffic and a reorganization); 46 million passenger-miles, up from 43,338,100 in 1954; and a general revenue load factor of 66% over 62.27%.

Italy

Alitalia and LAI, Italy's major airlines, made important traffic gains during 1955, readjusted their route structures, and entered 1956 with stronger government backing and plans for further expansion. Figures for the first half of 1955 show 128,068 passengers carried by the two airlines, up 31.5% from the comparable period of 1954.

Ciampino, the Rome airport, ranked third in Europe, with more than 11 million passengers handled in 1955.

Two DC-6Bs now on order will be delivered to Alitalia this month. Scheduled for 1957 delivery are four DC-7Cs and two Convair Metropolitans. LAI expects four DC-7s in 1957.

Japan

Japan's one major airline carried 302,882 revenue passengers a total of 198,363,769 passenger-miles over its domestic and international routes during 1955, compared with 279,297 passengers in 1954. Japan Air Lines' operating revenues were up from $10 million in 1954 to $14,700,000 in 1955, but expenses also were higher and profits dropped from $930,000 to $425,000 in 1955.

No new equipment was added in 1955 to JAL's fleet of five DC-6Bs and seven DC-4s, but the airline will receive an additional DC-4 this year and has ordered four DC-8s for 1960-61 delivery. Four Douglas DC-7Cs or Lockheed 1649As will be ordered soon.

A second important domestic airline will be established in Japan this April when two small lines, the Japan Heli-

A letter from Daddy
TO: BARBARA ALLARD
Dear Barbara:
I enjoyed your note about your favorite arthurs and I'm proud you're the intellectual type, workin' at the library, surrounded by good literature. Chances are you'll be a genius, since it runs in the family. No, I never heard of Ibsen and Chaucer but I once flew out of Teterboro with a Buzz Shakespeare. It's a weird handle and, if he's kin to the writer, I'll get you an autographed copy of that deal about the man with the crazy mother.
Frankly, honey, your ole man's no featherweight in the Brains Dept. either. F'rinstance, I do serious browsin' in the aviation magazines and boned up on AC Spark Plugs, figurin' anything a GM division makes — and Southwest Airmotive services and distributes — has to be the best. Result: We're now using AC in everything from our single-engine pipeline patrollers, to our Twin Beech and amphibs on the Gulf, and our DC-3 and Lodestar up Canada-way. AC's recessed "hot tip" prevents lead fouling; engines are smooth regardless of weather. On the Gulf, they've proved AC's "big barrel" plug is moisture-proof and cuts out "flashover." Up north, AC's platinum points give super-quick starts in ice and snow. All the Thinkers (including Buzz Shakespeare) are going AC 100%.
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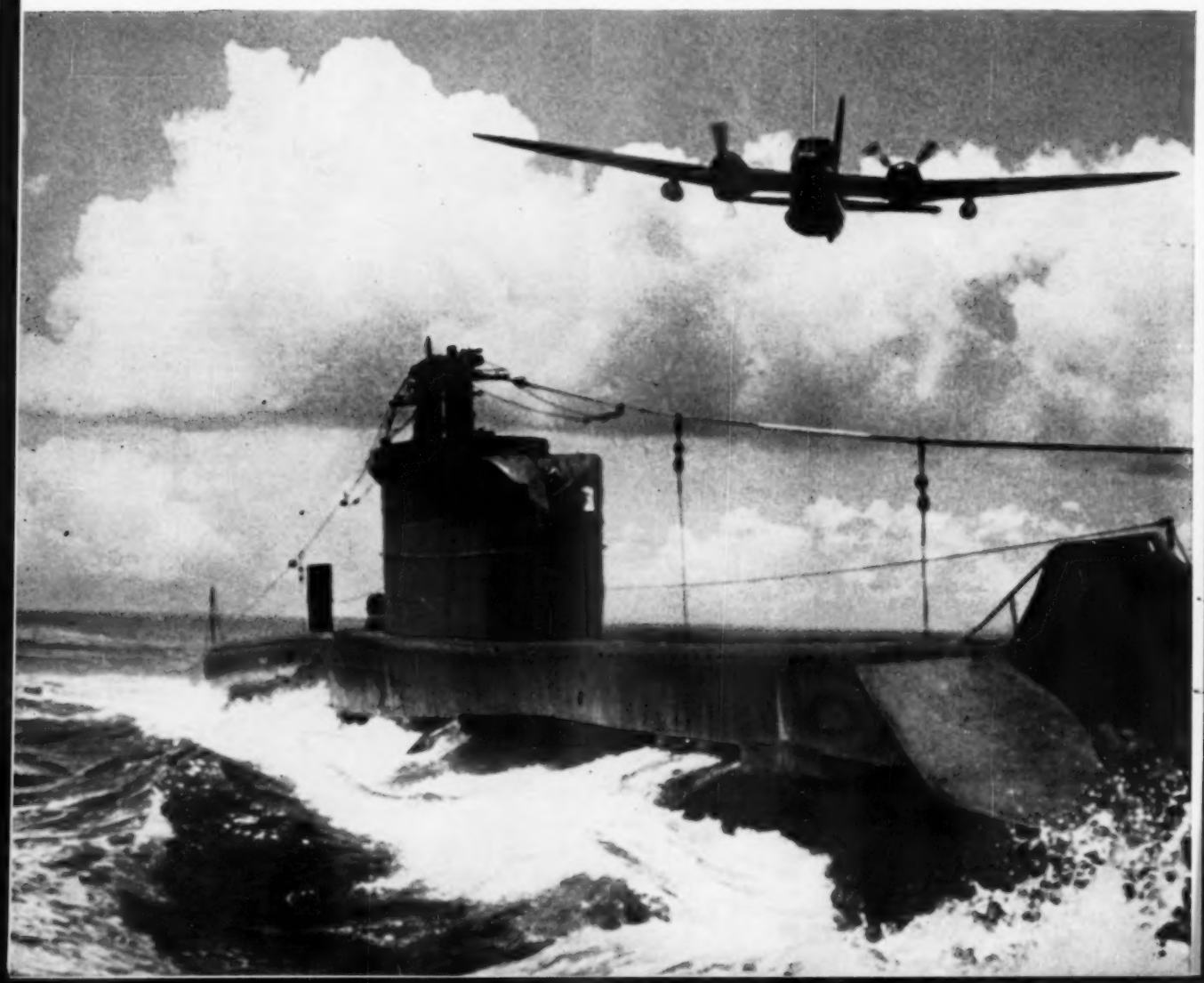
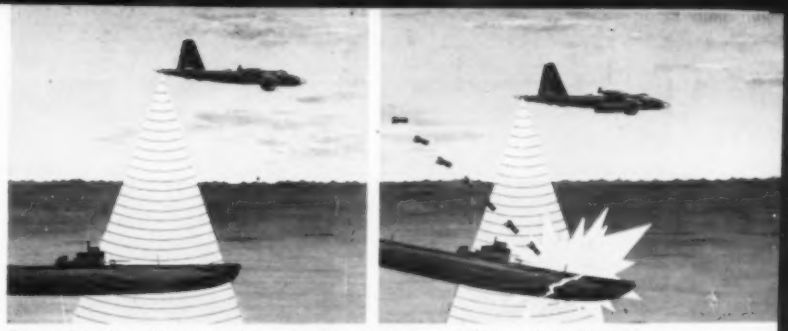
Official R.A.A.F. photo (below) shows war games "attack" on British sub by Royal Australian Air Force *Neptune*. (P2V's are in military service for the following friendly countries: Australia, Canada, Great Britain, France, Japan and the Netherlands.)



gressive modifications of the P2V have kept it militarily up to date at lowest cost to the Navy. Pound for pound, and dollar for dollar, the P2V *Neptune* is the most formidable patrol aircraft bearing the insignia of the U.S. Navy.

Recently the Navy awarded Lockheed its *24th* contract for P2V *Neptunes*—a tribute to Lockheed's leadership in weapons system management, the development and application of electronics, and the design and production of long-range patrol aircraft.



These drawings illustrate the multiple-mission capabilities of the P2V *Neptune:* **1** Low-flying P2V's electronic gear spots submerged sub because its presence distorts the earth's magnetic field. **2** Depth-bombing a submerged sub, **3** torpedoing a surface ship or laying mines to disrupt enemy shipping are jobs the P2V can do equally well. **4** Spotting hurricanes and reporting their velocity and direction are routine but important P2V missions which save human lives and vast sums in property damage.

Lockheed Missile Research Laboratories to Be Built in Stanford's Industrial Park

A series of research laboratories will be constructed by Lockheed's Missile Systems Division on a 22-acre site adjacent to Stanford University, Palo Alto, California. On a nearby site of 275 acres, at Sunnyvale, Lockheed will build extensive new engineering, manufacturing and administration facilities. Lockheed's 3,000 scientists, engineers and technicians now developing guided missiles and unmanned aircraft at Van Nuys will transfer to Palo Alto and Sunnyvale as rapidly as construction permits.

The proximity of both new sites to Stanford will make the university's outstanding academic resources available to Lockheed research teams. And the new laboratory facilities to be built by Lockheed will provide Stanford scientists with technological tools and consulting opportunities hitherto unavailable.

ATTENTION, STUDENTS WHO DESIRE MASTER OF SCIENCE DEGREES: Lockheed's Advanced Study Program *helps students achieve MS degrees in Mathematics, Electrical and Mechanical Engineering, Aeronautics and other physical sciences. Write:* LOCKHEED MISSILE SYSTEMS DIVISION, *Van Nuys, Calif.* *(Below: aerial photo of Stanford campus.)*

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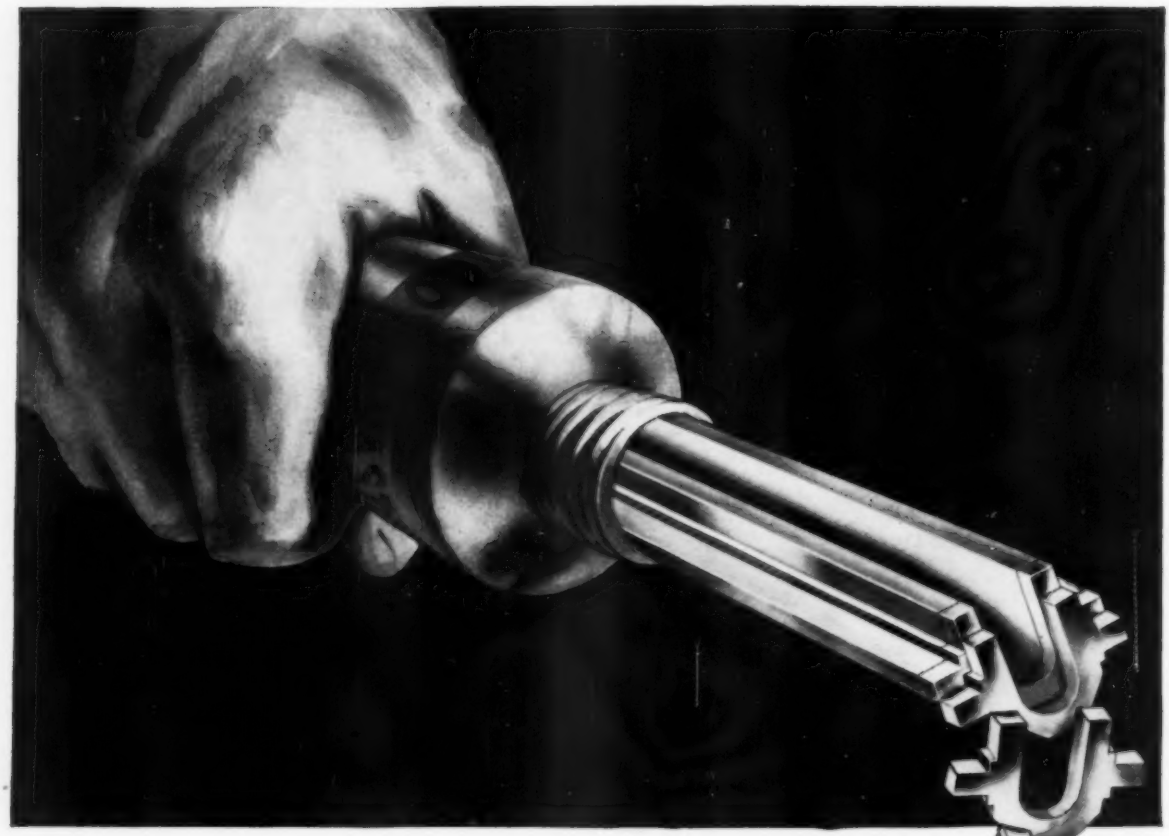

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copter and Transport Co. and the Far East Airlines, are scheduled to merge. The new company will buy three DC-3s and three Convair 340s and will concentrate on feeder-line type of service.

Mexico

The 32 foreign and domestic air carriers serving Mexico carried 1,305,807 passengers a total of 848,443,565 passenger-miles during 1955. Together they carried 7,453,349 pounds of mail, 56,474,018 pounds of express, and 30,012,468 pounds of cargo in Mexican service.

The question of a second carrier in the highly profitable Mexico City-New York non-stop run was still unanswered.

Last month Aerovias Guest became the first Mexican airline to inaugurate regular service to Canada.

Compania Mexicana de Aviacion, which flies to Los Angeles and Havana as well as to 27 Mexican points, carried about 500,000 passengers during the year. CMA ordered four Douglas DC-7Cs and three Fairchild Packets for 1956 delivery.

Aeronaves de Mexico, S. A., carried about 408,000 passengers.

Pakistan

The Pakistan International Airlines Corporation bit off a little more than it could chew in early 1955 by starting a weekly Super Constellation service between Karachi and London. Handicapped by lack of spares and business experience, PIAC was forced to cut the run down to one flight monthly.

On other routes, the Pakistan carrier was more successful. It continued a thrice-a-week Convair service to Bombay and added a Karachi-Delhi service with DC-3s. The airline inaugurated coach service on domestic routes and was competing with some success against first class railroad travel.

Pakistan International carried 80,000 passengers during the year for a total of 35 million passenger-mi., flew one million ton-mi. of freight and baggage and 200,000 ton-mi. of mail.

During the year, a technical assistance program, partly financed by the U. S. got underway. Pan American World Airways is supplying a team of experts to train PIAC in modern operations and management.

Philippines

Most important event in Philippine aviation in 1955 was the decision of Philippine Air Lines officials and President Magsaysay's administration to seek a new formula for allowing the airline to resume its transpacific flights. A bill is being prepared for presentation to Congress, which will provide for government subsidization, in some form, of a "designated flag-carrier."

Most observers believe the bill will have relatively smooth sailing, since most government officials now feel that it was a mistake to withdraw PAL from long-range international service.

The airline has never halted its short-range international flights to Hong Kong and Bangkok.

PAL's domestic scheduled traffic for the first nine months of 1955 included 265,953 revenue passengers carried, along with 170,330 pounds of mail and 3,251,167 pounds of freight.

Scandinavia

Scandinavian Airlines System began 1956 with its first profit ($1.7 million) since the group was formed in 1951. It had $104 million of new aircraft on order and plans for new and expanded domestic and international services.

In making its 1955 profit, SAS earned revenues, after commissions, of $63.7 million, compared with $51.7 million in the previous year. SAS flew about 931,000 passengers, 10.7 million kilograms of cargo and 4.4 million of mail.

Delivery of the first of seven DC-8s ordered from Douglas is scheduled for early 1960, and SAS will use the jetliners on its North Atlantic and polar routes. Delivery of 14 DC-7Cs will begin in August. SAS also ordered 11 Convair Metropolitans, with first deliveries scheduled this month.

SAS is seeking from the Russians permission to fly a trans-Asian route to Japan.

Despite past opposition to SAS's monopoly in Scandinavian domestic traffic, increased domestic services have strengthened SAS's control.

Spain

Iberia, Spain's wholly government-owned airline, carried 591,000 passengers in 1955, flying 10 million miles during the year, including 612 transatlantic flights. Iberia's fleet consists of two Super Constellations, six DC-4s, 16 DC-3s, and 10 smaller aircraft of various types. On order are two Super-Constellations, scheduled for 1957 delivery, and five Convair 440s.

The other Spanish airline, Aviaca, is 50% government-owned and flies domestic routes only. Its equipment includes six Bristol 170s and four Bloch Languedocs.

Switzerland

The Swiss National Air Navigation Company (Swissair) recorded increases in all categories of air traffic during 1955: passengers up 16%, cargo 39% and mail 14%. Revenues totaled about $32 million, a 17.1% increase over 1954.

Swissair has four DC-7Cs on order and early this year placed orders for two DC-8 jet transports for 1960 delivery.

when does $\Delta\phi_1 = \Delta\phi_2$?

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If the hysterisis loops of two toroidal cores shown in the sketch above, are identical in all respects, and identical windings are placed on the cores, then many magnetic amplifiers might operate as predicted, i.e. $\Delta\phi_1 = \Delta\phi_2$.

However, even if the above assumptions were true, then subsequent handling, impregnation, encapsulation and electrical history of the assembly must be carefully controlled in order to maintain the original performance characteristics. Here at Celco, a considerable amount of development and production experience is available for application to your particular magnetic amplifier problems.

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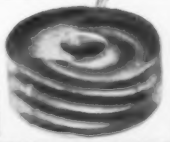

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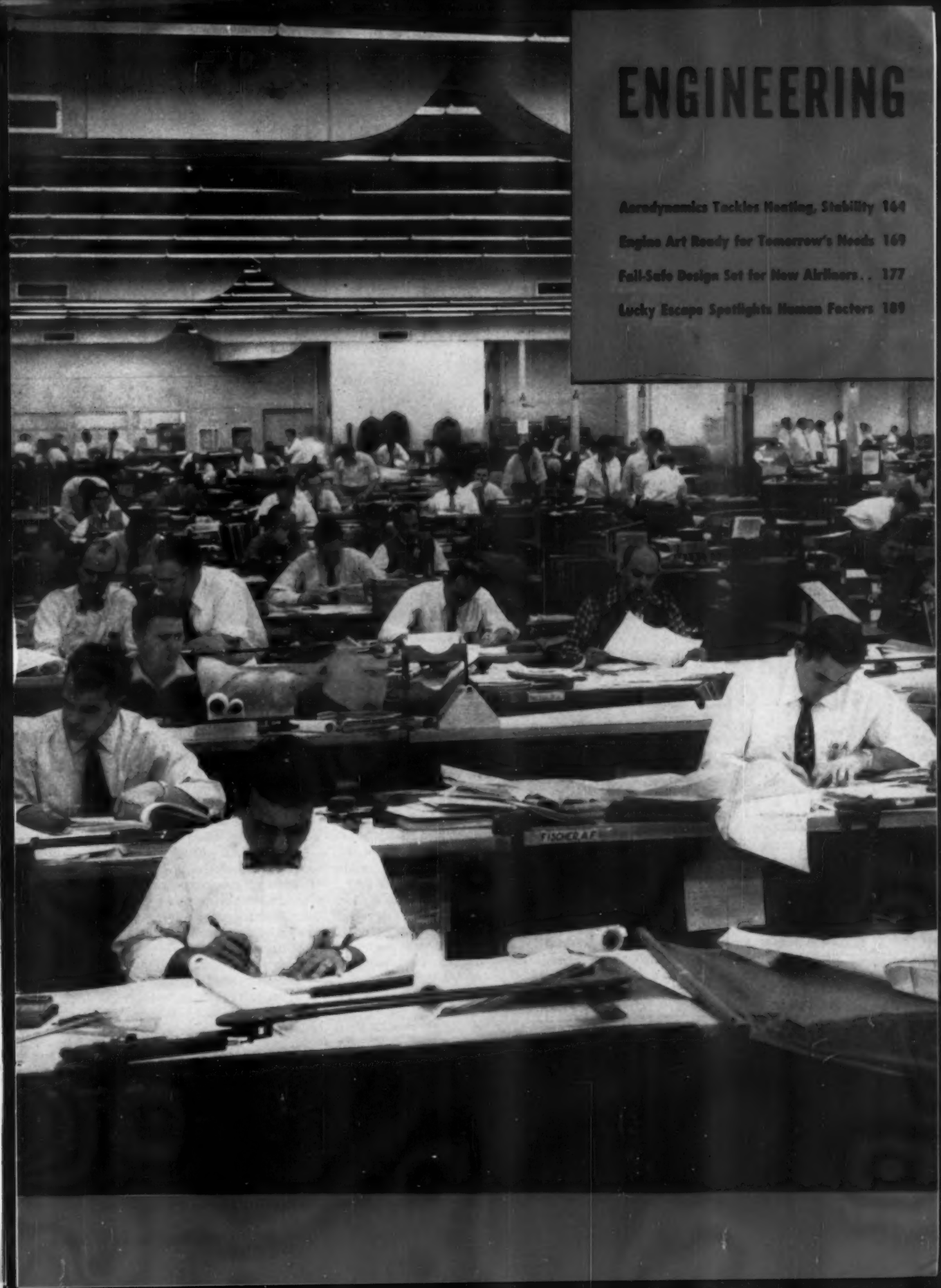

ENGINEERING

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Lucky Escape Spotlights Human Factors 189

F-101 MODEL READIED FOR TEST IN AMES LAB'S SUPERSONIC WIND TUNNEL

Aerodynamic Research Tackles Stability

Two major problem areas dominate today's aerodynamic scene:

• **Stability and control of highspeed aircraft.**

Almost every transonic and supersonic airframe in the air today has experienced some degree of instability about one or more axes. This tendency will continue as long as fuselages store more and more of the load, and as the sizes of lifting and control surfaces approach the vanishing point.

• **Aerothermodynamic questions about the design of intercontinental ballistic missiles.**

At hypersonic speeds, basic aerodynamic data of bodies and fins is rare and uncertain. The strength of the shock wave and the high heating break down the molecules of air into ionized gases.

The result: A shape of unknown lift, drag and moments hurtles through a medium of unknown characteristics.

On the Plus Side

To balance the gray side, substantial progress has been shown in three major developmental areas:

• **Drag reduction.** Extension of Whitcomb's area rule to speeds above Mach 1 has made it possible to sculpture for supersonic flight (AW Jan. 30, p. 30). Although the extended rule is more complicated to apply than the transonic scheme, results are just as dramatic. The first fighter so contoured is the Vought XF8U-1 Crusader.

• **Boundary-layer control.** After decades of experimentation, the use of boundary-layer control has begun to pay off.

Available air from the powerful compressors of today's turbojets means power for activating suction or blowing devices in wing leading and trailing edges. The payoff is in increased lift coefficients, mandatory with the thin, razor-edged wings of the next generation of flight.

• **Elimination of the runway.** The whole spectrum of vertical flight has been explored in a range of strange-appearing designs aimed at reducing takeoff and landing runs. Neighbors, noise and the tremendous investment in acres of concrete have forced the designers to consider methods of getting off the ground and back again on a near-vertical flight path.

ICBM Problems

Most dramatic of all the problems involved are those of the intercontinental ballistic missile. The specter of a near-incandescent missile plunging downward toward an enemy target has haunted many an engineer in a nightmare of design calculations. There are so many unknowns.

During its flight, the missile travels through a speed range from zero to the hypersonic Mach numbers around 10. The trajectory passes through the dense lower air, where continuity can be assumed, into the near-vacuum of extreme altitudes, where only an occasional molecule impacts the missile. Between these two extremes is the slip flow range, where air is neither homogeneous, nor mechanically molecular.

A successful ICBM must be stable and controllable over those ranges of conditions.

The prime difficulty facing the ICBM designer is the re-entry problem. Current thinking demands that the

U. S. Research Aircraft

Manufacturer and Address	Designation	Seats	Number, make, model, and power of engine	Maximum speed (mph)	At altitude (ft.)	Gross weight (lb.)	Span	Length	Height	Remarks
Bell Aircraft Corp. *Buffalo, N. Y.*	X-1	1	1 RMI-6000-C-4 @ 6,000 lb. t.	1,000	80,000	13,000	28′	24′ 6″	10′ 10″	First to exceed Mach 1, 10-14-47.
	X-1A[1]	1	1 RMI XLR-11-RM-5 @ 6,000 lb. t.	1,650[4]	90,000+[4]	16,000	28′	35′ 7″	10′ 9″	Turbine driven fuel pump.
	X-2	1	1 C-W throttleable rocket	2,250*	100,000*	.....	.....	.....	.....	Stainless-steel swept wings, K-Monel fuselage, tail.
	X-5	1	1 All. J35-A-17 @ 4,900 lb. t.	.....	.....	9,900	22′ 9″[3]	33′ 6″	12′ 2″	Variable-sweep wings. Transonic trials.
Douglas Aircraft Co. *Santa Monica, Calif.*	D-558-I	1	1 All. J35-A-11 @ 5,000* lb. t.	650+	.....	10,000*	25′	35′ 1″	12′ 2″	Set record of 650.6 mph. 8-25-47.
El Segundo, Calif.	D-558-II	1	1 RMI rocket[2] @ 6,000 lb. t.	1,327[4]	83,235[4]	.....	25′	45′ 3″	13′	Wings swept 35 deg.
	X-3	1	2 West. J34-WE-17 @ 4,500 lb. t.[5]	.....	.....	27,000	22′ 8″	66′ 9″	.....	High-speed, altitude research.
Lockheed Aircraft Corp. *Burbank, Calif.*	X-7	0	1 MAC or WAD ramjet	M=3	.....	.....	.....	.....	.....	Ramjet test vehicle.
North American Aviation, Inc. *Los Angeles, Calif.*	X-10	0	.....	.....	.....	.....	.....	.....	.....	Navaho (SM-64) guidance test vehicle.
	X-15	1	Liquid-propellant rocket	.....	800,000[6]	.....	.....	.....	.....	Extreme-altitude research.
Northrop Aircraft, Inc. *Hawthorne, Calif.*	X-4	1	2 West J30 @ 1,000 lb. t.	.....	10,000	7,000*	36′ 10″	23′ 4″	14′ 10″	Semi-tailless sweptwing. High-transonic tests.
Ryan Aeronautical Co. *San Diego, Calif.*	X-13	1	1 R-R Avon @ 10,000 lb. t.	.....	.....	.....	.....	.....	.....	Vertical-takeoff research.

* —Approximate
All. —Allison
C-W —Curtiss-Wright
MAC —Marquardt Aircraft Co.
RMI —Reaction Motors, Inc.
R-R —Rolls-Royce
WAD —Wright Aero. Div.
West. —Westinghouse
Lb. t. —Pounds thrust

[1]Other versions: X-1B, X-1D. Pilot ejection seat installed in X-1A. X-1D destroyed during tests, 8-23-51.

[2]Wings fully forward. With wings swept, span is 23 ft. 4 in.

[3]Originally fitted also with one Westinghouse J34 to provide takeoff power and climb to altitude. Turbojet later removed from at least one of three Skyrockets to make room for more rocket fuel. Plane then carried aloft in belly of Boeing P2B-1S Superfortress.

[4]This figure achieved during course of high-speed or high-altitude trials.

[5]Originally 2 Westinghouse J46 jets of approximately 7,000 lb. thrust each scheduled for X-3

[6]Design altitude.

and Heating

missile hit the target, rather than detonate in the air above it. That requirement means getting the warhead intact to the ground.

During re-entry, the missile is near its maximum speed. The combination of speed and increasing density of air causes an extremely strong shock wave to form at the missile nose, and a tremendous rate of heating on the skin. Between the shock wave and the nose, the heat is strong enough to jar some of the electrons loose from the atoms of air, making an ionized gas.

The properties of ionized gases under such conditions have yet to be determined, but must be, in order to predict the performance of the missile.

Heating of the missile skin can be calculated, once the boundary layer condition is known. But other basic aerodynamic parameters of lift, drag and moments must be calculated by theoretical means, using extrapolated data or extremely sketchy results from shock tube tests made in milliseconds.

The race for the ICBM will produce operational missiles that will work; but it promises to be a much longer time before there will be any precise theoretical explanation of their successful operation.

Shake, Rattle and Roll

Commonest complaints on any engineering test pilot's gripe sheet today are aligned under the column reserved for stability and control. The results of these lists show in the doctored outlines of wings and tail surfaces, now sporting leading-edge changes, vortex generators and fences.

Wing drop, kicked off by premature shock stall on one wing because of manufacturing irregularities, has been almost completely licked. There have been no recent cases of this instability.

But pitch-up continues to be a problem. This violent maneuver, caused by a sudden forward shift in wing center of pressure as the tips of a swept wing stall, can be avoided somewhat by proper tail placement. Dropping the tail below the thrust line, as in the North American F-100 and the Vought F8U-1, keeps that surface out of the downwash from the wing and keeps it effective as a trimmer when the center of pressure starts to go.

The low-slung tail has its own problems, because at negative angles of attack it is in the downwash of the wing, and its effectiveness is reduced.

Most of the post-production fixes made on wings are attempts to solve the pitch-up problem.

The means of directional stability are in short supply in current military planes. The reasons are inherent in the aerodynamics of the tail and fuselage.

As Mach number increases, the slope of the lift coefficient for any lifting surface decreases. This means that for a given angle of attack, there is less lift available at higher Mach numbers than at lower ones. This is true if the lifting surface is horizontal and called a wing or a stabilizer, or if it is vertical and called a fin, or vertical stabilizer.

Disturbing Loads

While the available lift or yaw coefficient is decreasing, the moment due to lift on the fuselage is increasing. All fuselages produce some lift or side force at angles of attack or yaw; most of the time these forces are small. But at higher Mach numbers, the forces build up to a magnitude that requires huge stabilizing surfaces to counteract the disturbing loads on the body.

Aerodynamically, the larger the vertical tail, the better the directional sta-

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bility and the less chance of trouble around that axis. But a large tail means weight and structural problems.

Roll coupling is another tough situation. Today's military aircraft have all their weight strung out along the fuselage; wings are too thin to carry much of the airplane's load. The moment of inertia in roll of the entire airplane, once the largest of the three moments, is now the smallest. Damping in roll has almost disappeared, and so the airplane rolls at an angular velocity much higher than that of a decade ago.

The result is that the large angular velocity produces a high angle of yaw on the nose of the fuselage, tending to throw it out of the roll. If the speed is high, this force is large; and unless there is enough vertical tail surface to override the loads, the airplane and the pilot are in real trouble.

These dynamic problems of stability show where the real advances in the aeronautical art must come in the near future.

The designer does not now have stability derivatives—rates of change of the stability parameters—in enough quantity to be able to use them as tools in his layouts. Measuring those derivatives is a tough job, and is mostly a question of developing wind tunnel techniques over a wide range of Mach numbers and angles of attack, roll and yaw.

Additional help for the harried designer will come from artificial flight data, gathered on the ground by simulators and computers. Creation of artificial flight data has already been of considerable help; it has given enough of a backlog of basic information so that engineers can explain what has happened in flight tests.

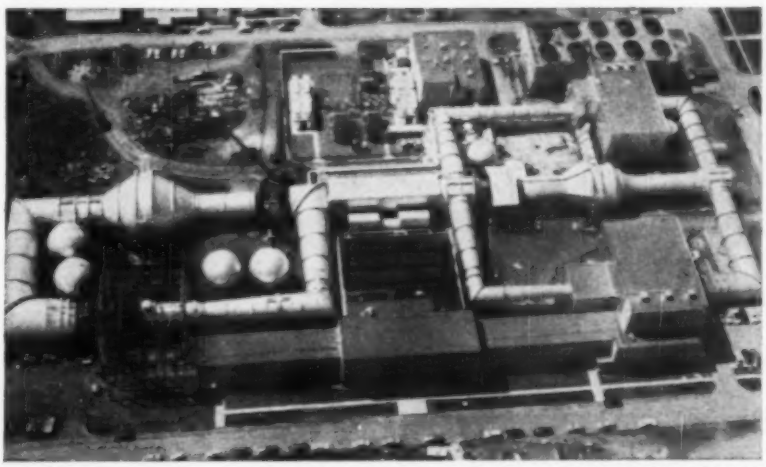
Non-Aerodynamic Control

But most of these expedients are just that, and are regarded by some aerodynamicists only as a temporary solution that pushes the useful Mach number a few points higher. The final answer, they believe, is some form of non-aerodynamic control. Their argument is a simple one: As long as Mach numbers increase, aerodynamic effectiveness will decrease.

The approach might be with gimbal-mounted engines, or some sort of jet vane control, commonly used in rocket-powered missiles. These direct control methods have much to offer, and there is enough experience behind their design and operation to give a fairly solid foundation for their use on the next generation of planes.

Another suggested solution is to take the lateral controls off the wing completely, and operate the tail differentially for roll as well as in the conventional manner for pitch. This method has seen use on the French rocket-powered interceptor Trident, built by Sncaso. Trident has three tail surfaces in planes 120 degrees apart.

DOUGLAS CONCEPT OF FUTURE FIGHTER



NEW AMES WIND TUNNEL FOR TOMORROW'S DESIGNS

These detailed control schemes are one of the groups of factors that will make the airplanes of tomorrow successful.

Right now, it's possible to predict some of the major aerodynamic design trends: Fuselages will get longer and slimmer, wings thinner and smaller, although without much more sweep than current practice.

Ventral Tail Surface

A ventral tail surface may sprout on the underside of the supersonic body, to handle the directional control when the aircraft is at high angles of attack and a dorsal tail would be in the airflow shadow of the wing.

Straight, thin wings with raked tips echoing the Mach cone angle are a probable future design feature.

These are broad trends, and are predictable now from the general mass of aerodynamic data gathered in the tunnels and on flight tests.

But it is the little detailed design features that are unpredictable. They will be dictated by the performance of the completed aircraft, and will—to a large extent—determine the final worth of the airplane as a weapon or a transport.

The state of the aerodynamic art today is such that we can explain what has happened during a flight test; but we can't say with any certainty at all what might happen.

It is a two-phased problem that must first be defined, and then solved.

In the accurate definitions of these problems and the inventive solutions to them will lie the real promises of supersonic and hypersonic flight.

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Engine Art Ready for Tomorrow's Needs

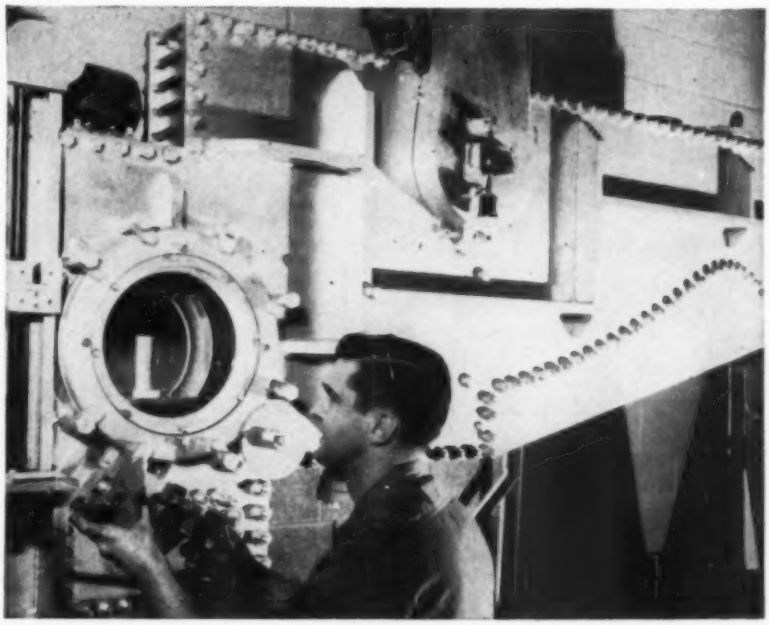
By Robert Cushman

Propulsion art is now better equipped to meet the growing demands of aircraft and missile designers than ever before. After slowing down a bit to recover from early growing pains and to increase reliability, powerplant progress this side of the ocean is ready to make new jumps in performance.

Progress is virtually guaranteed by:

- **Willingness of military** and commercial users to foot the bill for the new engines.
- **Broadening theoretical** possibilities.
- **Brand new mammoth,** elaborate Government and private test facilities which for the time being at least are more than adequate to develop better engines.

The first chapters of turbine development are completed. Reasonably advanced turbojets like the J47 already are being phased out of production. Some 35,000 J47s were manufactured. Their overhaul life (1,400 hr.) has been comparable to piston engines and the price has come down. (Orenda of Canada said that in moving from pilot to full production the cost per pound of thrust of its engines was cut from over $20 to $10.)



COMPRESSOR BLADE TEST AT GENERAL ELECTRIC

Turboprop Success

And, at this point, one commercially successful turbine engine is making its way in the non-military world: the 1,200 to 1,600 esph. Rolls-Royce Dart turboprop. In the first 25,000 hours of its Viscount operation, Capital Airlines says it has not had a single engine failure. Priced at $38,000, the Dart is running 1,000 hours between overhaul.

Military experience with medium and large turboprops has been equally encouraging. Two Convair YC-131Cs powered with 3,250 hp. Allison YT56s have accumulated 2,500 hr. at an average cost of $129.44 per flying hour. Two Boeing YC-97Js in service with MATS have flown 500 hours with 6,000 hp. Pratt & Whitney T34s.

"The turboprop transport is our only practical answer to the demands of cost, speed, economy, flexibility, noise and safety," says USAF Lt. Colonel R. J. Wellman. He points out that a turboprop transport could operate out of hundreds of airports existing in this country at present against the bare handful accessible to a turbojet transport.

Added to this is the growing proof that the public now prefers turboprops, although there are indications that the same public trend may shift the preference on to turbojets once they are available, warns J. D. Pearson, managing director of Rolls-Royce's Aero Engine Division. This may force airline operators to buy turbojets for some of the medium stage lengths where turboprops are technically superior.

It is likely that ticket buying habits may have a profound influence on aircraft gas turbine engine development.

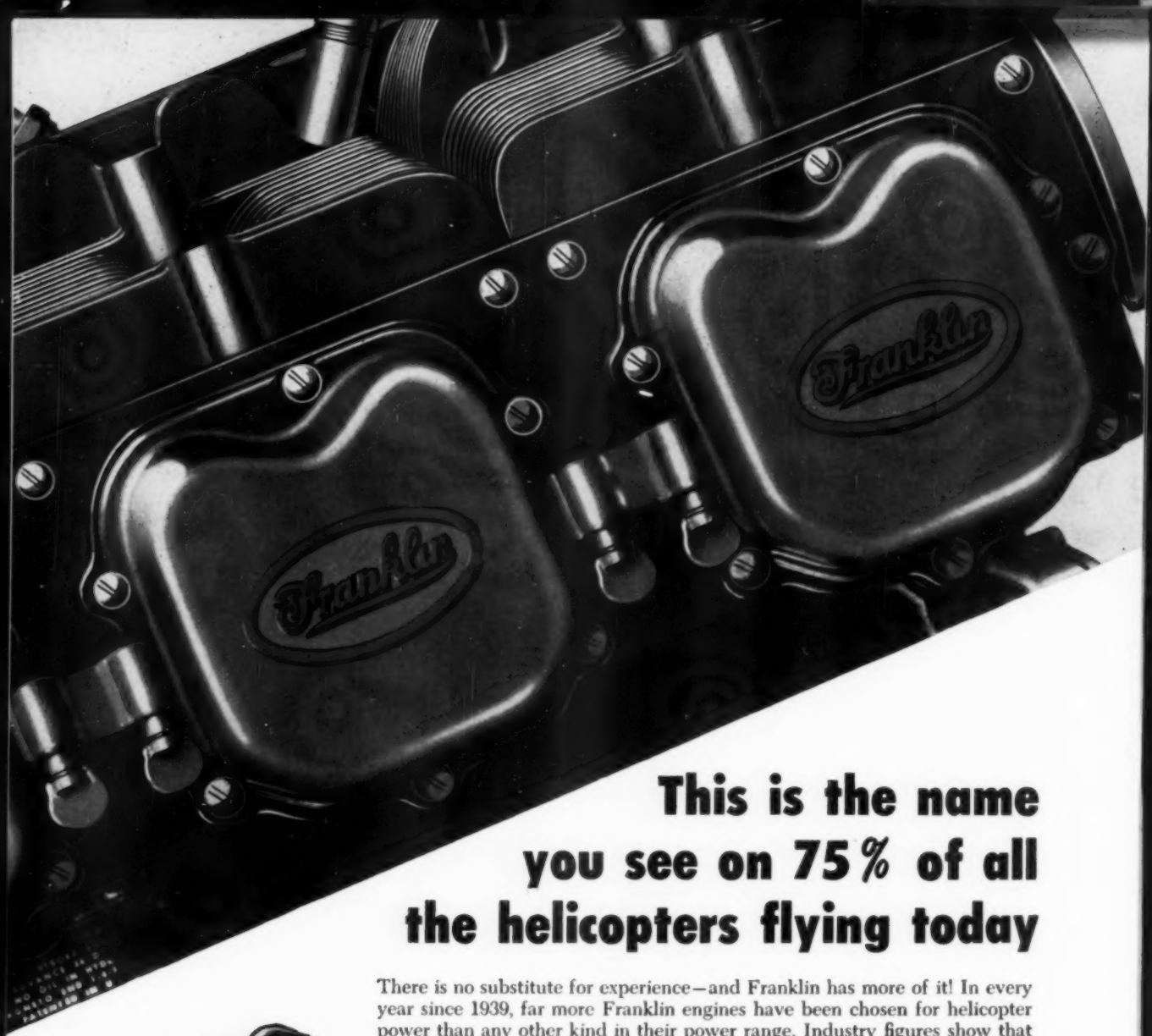
The mounting commercial orders for the Boeing 707, the Douglas DC-8 and the Lockheed Electra highlight the next chapters. These orders are at the mercy of the engines around which they are planned, P&W's J57 and J75, Rolls-Royce Conway and Allison 501.

As the enthusiasm is mounting so are the problems. New problems result because the military want engines which will cruise fighters two to three times faster and two times higher than ever before. The commercial field is anxious to overcome anticipated public objections to noise and land-hungry airports which could set back jet airliners many years.

Engine-Airplane Integration

To go faster than sound, it is imperative that the propulsion system integrate inside the plane with as little drag as possible. It is not enough that the engines have high thrust—the engine-airframe combination must have

NEW DEVELOPMENTS: HONEYCOMB AND PLASTIC



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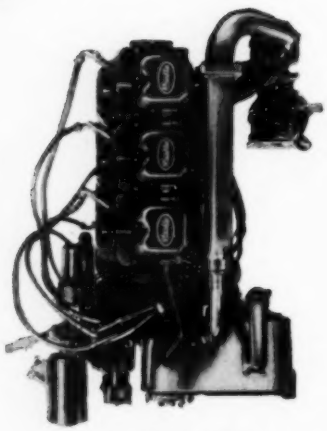

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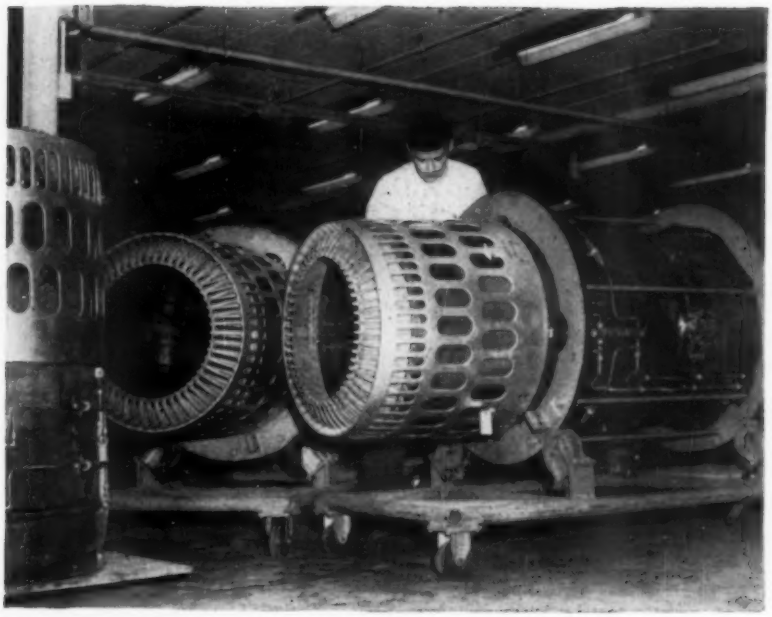


J65 AFTERBURNERS PRODUCED BY RYAN

high thrust with minimum drag.

Furthermore, the airplane that goes fast enough probably will not be able to take care of itself in the low speed landing regime. The propulsive system may be called on for direct vertical lift, either by compressor air bleed for boundary layer control flow or mechanical deflection of the jet. When the airplane is on the ground the engine will be called upon for reserve thrust.

Integration works both ways. To protect his product's performance guarantee, the engine manufacturer is becoming vitally concerned in what sort of inlet ducting and exit nozzling the airframe manufacturer is leading up to and away from the engine. As many engine manufacturers may be looking over airframe drawing boards in the future as airframe people waited impatiently for new engines in the past.

Engine Objectives

What this trend of aircraft-engine integration means for the engine manufacturer is a further intensification of engine design objectives:

• **Reduction in weight,** decrease of frontal area, improvement in specific fuel consumption, raising of thrust, and increase in reliability and life.

• **Thrust is being increased** by higher turbine inlet temperatures and supersonic exhaust nozzles. Drag is being decreased by smaller frontal areas, lighter weight engines, and by lower specific fuel consumptions.

The new engines do not look much bigger than the older ones but much more air is being squeezed through their diameters, and the amount of metal which forms the engine is being cut to the bone.

Previous emphasis on high compressor ratios has been shifted to lighter compressors, because at Mach 2.0-3.0 the ram compression needs only modest boosting. At Mach 2.5 the turbojet will become a ramjet; the rotating compressor-turbine is carried along only to bring the aircraft up through the low speed range.

For high supersonic flight, therefore, it does not seem that the weight and complication of the dual-spool compressor will be justified, according to J. S. Alford of General Electric.

Unfortunately along with the "free" inlet compression there is a disastrous heating effect at supersonic speeds. This ram temperature rise is reflected back through the engine to other parts already critically overheated.

A divergence exists in subsonic turbojet engines for long-range military and civilian transports. Less emphasis is required on power per frontal area and light weight and more on reliability and economical fuel consumption.

It is hard to draw the line because most of the actual turbojets which are going to be used in commercial transports are conversions from military powerplants. Development of the turboprop will be watched with much interest: not only do military and civil requirements more nearly coincide in this program, but to a greater extent civilian demand will be forced to underwrite the lagging evolution.

Pratt & Whitney and Allison have definitely committed themselves to "big" engines. They say big engines will make the most effective pod installation for bombers and transports, and are the only type which can now power a supersonic fighter.

Others like Fairchild and Westinghouse seem to favor the smaller sizes which they say will have such high thrust to weight ratios that can overcome higher specific fuel consumptions. Continental and Lycoming like the baby sizes because of their previous interests in small engines.

General Electric and Curtiss-Wright are playing on both sides of the fence but with distinctly separate groups. Each group aims at particular types.

Designers are forced to add more controls to keep the engines somewhere near design performance, that narrow zone between either overtemperature or surge and underperformance. Multiple spool compressor-turbine combinations, variable angle blading and variable inlet and exit geometry must be regulated by artificial safety limit and optimizing systems. Their control is too complicated to add to the already heavy burden of the pilot. Future engine controls may be integrated with the aircraft flight controls in one black box, says Dr. E. H. Gamble of GE.

If political and civil lethargy continues to hold back the building of "new-type" airports, the question of whether the jet age will be ushered into service without wasteful quarrels and lawsuits may rest squarely in the laps of the engine manufacturers.

The airframe manufacturers are now doing part of the engine manufacturer's jobs for them.

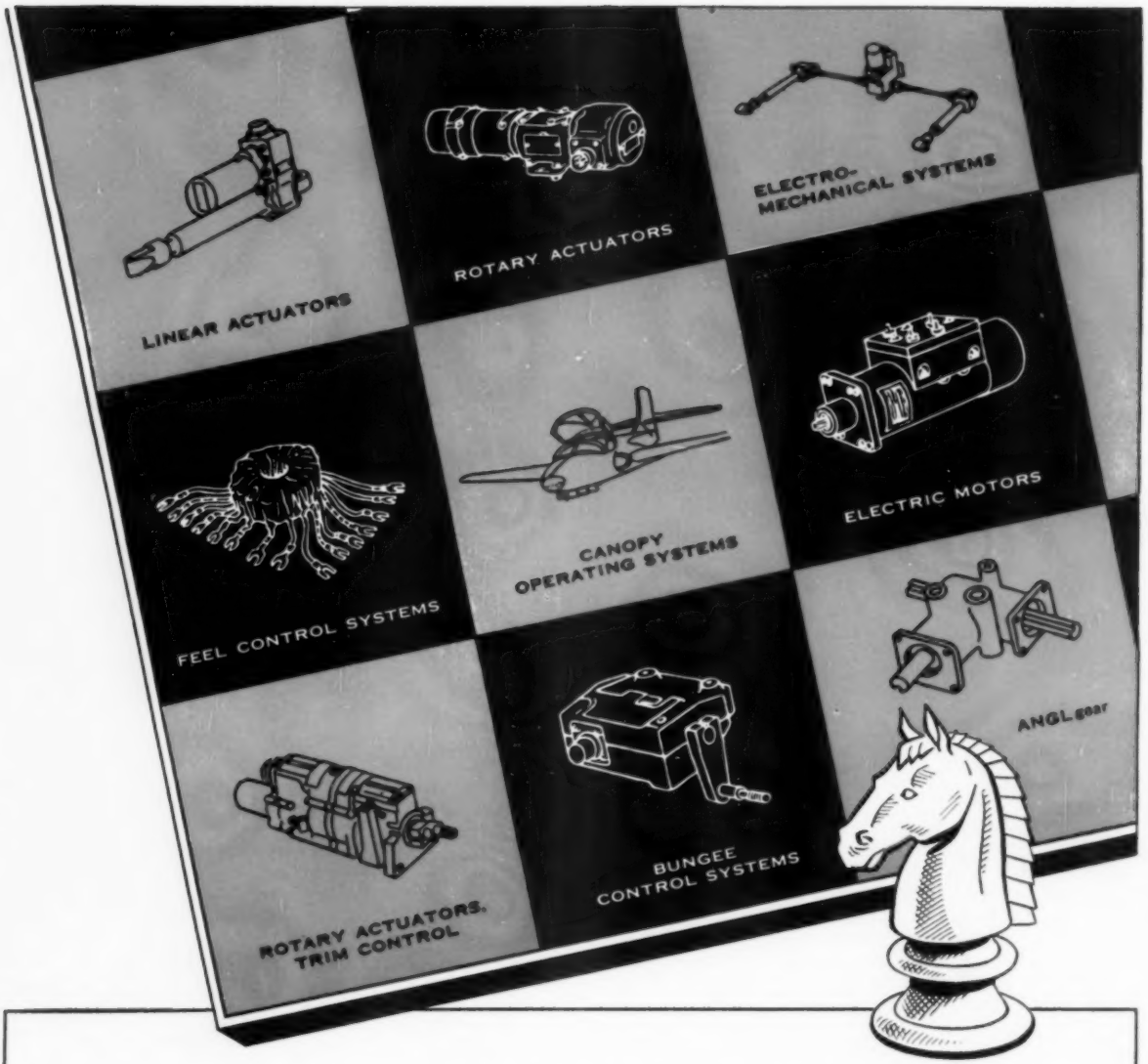
Both Douglas and Boeing are working on experimental fixes to engines in an effort to solve the noise and runway length problems. But fixes may affect the engine performance so drastically that the engine builders had best take the responsibility of designing acceptable characteristics into their engines.

Old Problems Too

Most problems which plague development engineers are continuations of problems at least five years old, as outlined before the IAS then by Abe Silverstein of NACA's Lewis Flight Propulsion Laboratory.

• **High operating temperatures** are the classic problem of gas turbines. In no other form of engine are critical parts laced so unrelentingly, without cooling relief, in the center of "fire." Most gas turbines do have quite a bit of cooling but the parts which need it most, the turbine blades, usually have none. Means of blade cooling are under study, and the search is still on for heat-resistant materials.

• **Internal aerodynamic problems** have been greatly aggravated by the urgent necessity of the high airflow per small



Your move

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diameter of a multi-stage axial flow compressor. Ironically, the aircraft industry has been faced with the situation where there are now many more airfoils to worry about inside the plane than there ever were outside. The threat of stall perhaps is even more worrisome and the results more disastrous. A stalled aircraft, given altitude, has a chance to recover, but a stalled compressor usually destroys itself. Development groups still are trying to find out all that goes on inside a compressor. They are trying to find out to what extent the secondary flows in the boundary layers cause clogging of latter stages and surge.

• **Combustion art** remains just that: of all that goes on in the engine the least is known about this phenomenon. New high performance fuels may permit smaller diameter or shorter combustion sections, but the necessity of mixing primary airflow with secondary to cool the turbine blades will remain. Use of high-speed motion pictures and high-frequency recordings may provide the means for accumulating information for building better combustion theory.

• **Manufacture of gas turbines** is still in its youth. Engineering changes to a large extent prohibit the degree of standardization and mass production needed to see how far the price can be lowered. Complexity of a jet is illustrated by E. K. Brownridge, vice president-manufacturing, Orenda Engines Ltd. of Canada. He says the Orenda has 16,000 parts of which 1,700 are turbine and compressor blades.

One achievement of the past year has been the increase in brazing facilities, and the larger size and greater complexity of parts which can be handled in metal brazing oven. Honeycomb sandwiched between sheet metal and brazed together will help create light weight jet engines. When used as a tail cone for example, it could provide greater rigidity and decreased weight. There also is the possibility of using the dead air space in between for cooling.

New Approach

Practically all the engine manufacturers have been quietly but extensively reorganizing their approach to new engine development. The present popularity of Pratt & Whitney's J57 can be directly traced back to that company's aggressive far-sighted decision six years ago to spend $14,000,000 of their own money to set up an engine development laboratory. Although too late to share in the initial stages of the J57's 7 year development program the Willgoos laboratory gave important direction to the 14,200 hours of experimental flight test running and 4,000,000 individual complex mathematical problems solved by electronic computers, that made up the typically vast labor of bringing out a successful modern turbojet engine.

Old Ways

In the past, defense manufacturers tended to build new propulsion devices in a quick "one-shot" way. They conjured up hardware that would run in some fashion. Then, they ran the thing on a stand, took a look at what they had done or had not done, and then concentrated one by one on the engine's most obvious failings until they had brought the engine up to an acceptable performance or abandoned it as obsolete.

The cost of a turbojet engine is put at $25 million over a five year period. This is a minimum figure, exclusive of subsequent tooling, and is spent prior to production, if any. New types must be carefully selected and realistically evaluated.

The answer is to employ mature methods of developing engines, using all of the time-saving analytical and computing devices available—and test facilities in which we can learn as soon as possible whether the new engines are really coming along.

Evaluation Centers

The advanced development facilities at Lewis Laboratory, NACA's propul-

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sion section—for a long time our only large propulsion facility—are being further expanded. The new gigantic Air Force engine evaluation center at Tullahoma, Tennessee and the similar, but not as large, Navy facilities at Trenton, New Jersey, are nearing completion, with some parts already in operation.

Government facilities remain the major source for complete engine testing, but the degree to which private industry is now approaching these Government facilities and actually planning to match them in certain respects is remarkable.

Pratt & Whitney which was first in the field five years ago with their Willgoos Engine Laboratory, is the only engine firm which has not made a publicized jump in facilities in the past year. General Electric, Allison, Westinghouse, Curtiss-Wright and Fairchild are in the midst of expanding their facilities.

Most striking is General Electric's intention to build a large $20 million Mach 3.5 propulsion windtunnel by 1958.

Allison says that a good part of its present $75 million expansion program will be devoted to developmental facilities.

Westinghouse, which has admitted that lack of facilities were behind the J40's trouble, is staging a comeback with a $12.5 million facility in Kansas.

Curtiss-Wright's $18 million ramjet testing facility, now in operation, can contribute to that company's turbojet program.

Fairchild has just completed a $2-million facility for small turbojets, and other firms have also increased their propulsion facilities.

Special Equipment

The size of these still-growing facilities is mostly beyond comparison with any type of commercial equipment existing.

For example, Lewis is the largest single customer of power in the heavily industrialized Cleveland area, and Allison's new development facility will use as much water as Indianapolis.

Most of the powerplants for the new facilities have been specially designed for the purpose. Tullahoma's 16-ft.-diameter propulsion windtunnel will be powered by the largest rotating machinery in the world. Only the smaller facilities can use commercially available equipment: Fairchild uses steel blast furnace blowers.

The largest of the tunnels must provide power ratings as high as 100,000 hp. to move air at rates of 450 lb. per second. (Intermittent tunnels may have flow rates as high as 850 lbs. per second.)

There is fear that these magnitudes may be outdated in the near future.

But the facilities in themselves guarantee nothing. They are just big steel and concrete structures with huge brute force powerplants unless they are put to work intelligently.

The data sensing, recording, reducing and computing systems which go along with these facilities are as advanced and remarkable as the cells themselves. By interlocking systems of instrumentation, tape recording, digital and analog computing and reduction the systems can be made to approach the test ideal of automatically reducing the thousands of test readings into form immediately useable for making engineering design decisions.

The trend to electronic sophistication, because of its firm mathematical base, can be expected to have a stimulating effect on the creative testing process. Such intelligent facilities will expedite technological breakthroughs.

Future Propulsation

Although the manufacturers are becoming better provided with their own facilities NACA's Lewis Lab says it has no intention of slackening its efforts. For, while a manufacturer must confine himself to making limited solutions come to life, NACA feels it is its job to offset the producer's tendency to reject other ways of doing something in favor of one workable solution.

A growing interest which could revolutionize the whole propulsion picture is the possibility of new "high-energy" fuels.

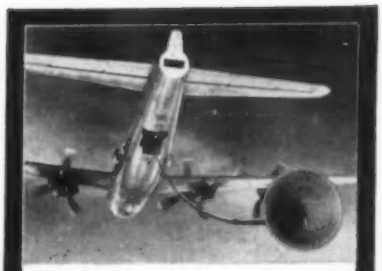
Chemical companies have been working on fuels which can give the same or better results for less weight and less tank volume.

The new chemical fuels could be just as important as the nuclear fuels, and certainly there are fewer obstacles to immediate utilization. Boron, lithium and hydrogen are some of the chemicals mentioned with respect to the new "exotic" or non-hydrocarbon fuels.

The successful application of nuclear power first to test vehicles, then to military and eventually commercial aircraft is still in the future. Following this unconventional kind of powerplant may be an even more unusual propulsion spectrum.

The near-vacuum of extreme altitudes makes feasible the use of high-energy propulsion streams of low mass, such as a neutron jet. Compared to the huge thrust of a modern turbojet, the neutron stream has minute power; but if there is no air drag, the size of the thrust is only of academic interest.

Another concept may offer promise: the radiation of electrical power from remote ground-based power stations to receiving and transforming equipment in the field.



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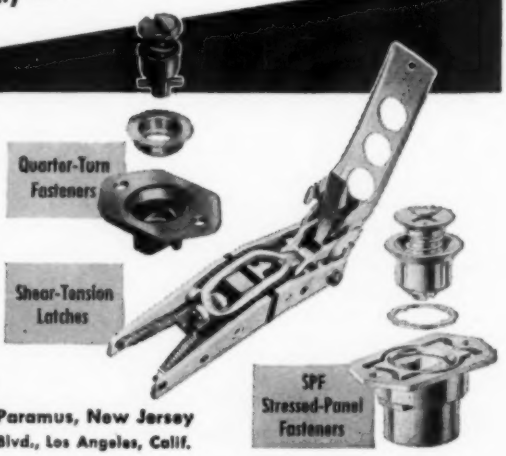

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Fail-Safe Designs Set for New Airliners

By Irving Stone

Structural designers of civil transports are putting a new accent on safety, designing fail-safe structures for the turbojet and turboprop airliners just over the horizon.

A fail-safe structure is one which can sustain an "honorable" load after any one major element of the structure has failed. This load generally is interpreted to mean approximately 80-85% of limit load. Ability of the remaining structure to support this load is translated into the aircraft's ability to land safely and discharge passengers.

Designing fail-safe characteristics into a structure imposes a weight penalty. But the additional weight involved is small, being of the order of 0.25% of the empty weight of the plane, compared to a structure not designed for fail-safe or fatigue.

In the case of the Lockheed Electra turboprop, with an empty weight of approximately 50,000 lb., the introduction of fail-safe provisions is expected to add only about 125 lb.

Alternative to the fail-safe makeup, designers say, is a structure with such a long fatigue life that a crack would not be expected to occur during the useful life of the aircraft. This approach results in a structure considerably heavier than one designed fail-safe. Also, it is considered impractical because of the uncertainties in predicting the fatigue life and because it may not provide for sources of failure other than fatigue.

Multiple Members

In a fail-safe structure design, the members are arranged, stresses used and materials chosen so that the structure can survive and sustain approximately the limit load after failure of a major element. Multiple members rather than single members are employed. Thus, instead of an integral spar cap and web, these would be used as separate units. This general arrangement has been used in American designs for many years, probably because production considerations dictated separate spar and cap. Inadvertently, this made structures fail-safe to a degree.

Fail-safe design today, in a sense, exploits this past design and improves on it by making the complete flight structure so that there are no unsafe elements. An unsafe element is one in which failure could result in loss of the plane.

Some designers, particularly those concerned with military aircraft, resent any implication that a structure is necessarily unsafe if it is not designed fail-safe. The fail-safe concept is a desired objective, they admit but point out that due to the high density of military planes, structural space provisions may be at a premium in military aircraft. This often makes a multipath structure impractical. Hence, added margin of safety, such as increased material, is sometimes necessary in a single load path structure to counteract the adverse effects of fatigue.

Pressure Cabins

With the era of high altitude transports approaching, designers are refining pressure cabin structures to insure top safety provisions.

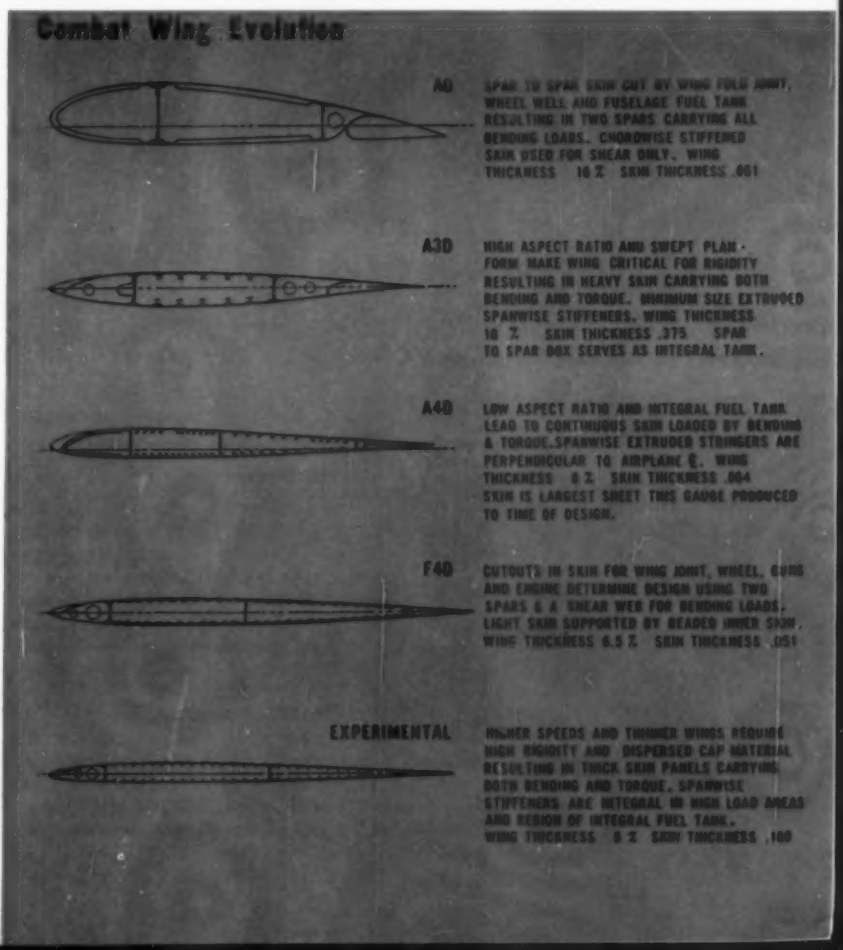
The Comet accidents demonstrated that the plane, particularly the pressure cabin, cannot be designed for static ultimate strength alone, but must be designed to endure many repetitions of much smaller loads. This may dictate structural members heavier than required simply for static ultimate strength. This approach may apply particularly around cutouts or other discontinuities in the structure, such as splices or wing-to-fuselage joint.

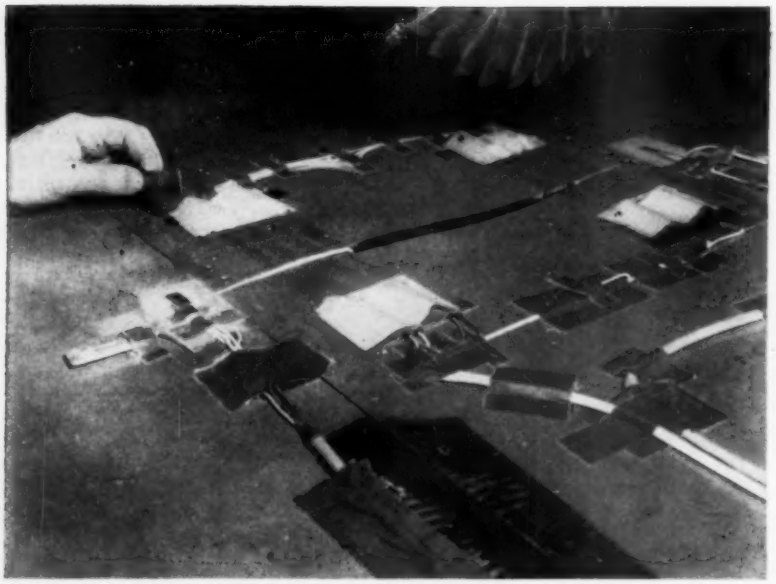
Sharp corners on window, door or hatch cutouts must be avoided. Reinforcements at cutout corners must be designed to reduce the stress level low enough so that cracks will not develop during the life of the plane.

Material of high ductility is considered necessary for skin to minimize susceptibility to fatigue cracking and to reduce rate of crack propagation. Many designers consider 2024-T3 the optimum material for pressurized fuselage skin, because of its ductility and resistance to crack propagation. A gage of 2024-T3 thinner than any other aluminum alloy will provide the necessary degree of fatigue resistance.

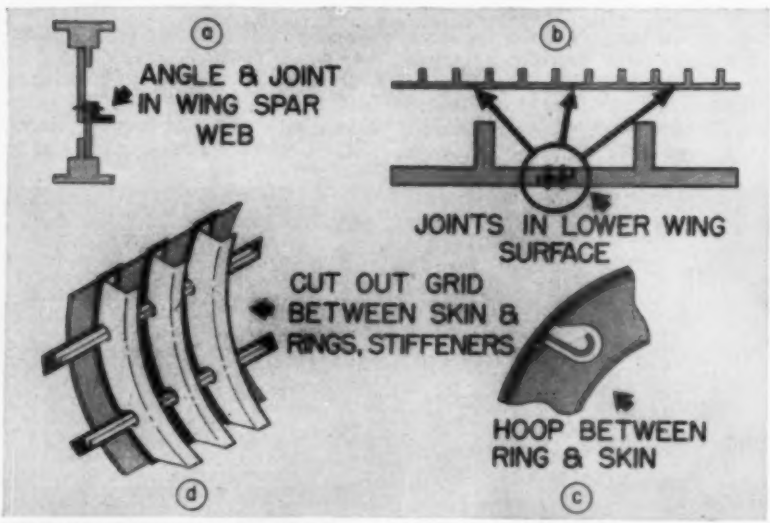
Reinforcing straps placed between fuselage frames and skin are being considered as a means of stopping cracks.

Consideration is being given also to


Combat Wing Evolution
A0
SPAR TO SPAR SKIN CUT BY WING FOLD JOINT, WHEEL WELL AND FUSELAGE FUEL TANK RESULTING IN TWO SPARS CARRYING ALL BENDING LOADS. CHORDWISE STIFFENED SKIN USED FOR SHEAR ONLY. WING THICKNESS 10 % SKIN THICKNESS .051
A30
HIGH ASPECT RATIO AND SWEPT PLAN-FORM MAKE WING CRITICAL FOR RIGIDITY RESULTING IN HEAVY SKIN CARRYING BOTH BENDING AND TORQUE. MINIMUM SIZE EXTRUDED SPANWISE STIFFENERS. WING THICKNESS 10 % SKIN THICKNESS .375 SPAR TO SPAR BOX SERVES AS INTEGRAL TANK.
A40
LOW ASPECT RATIO AND INTEGRAL FUEL TANK LEAD TO CONTINUOUS SKIN LOADED BY BENDING & TORQUE. SPANWISE EXTRUDED STRINGERS ARE PERPENDICULAR TO AIRPLANE ℄. WING THICKNESS 8 % SKIN THICKNESS .064 SKIN IS LARGEST SHEET THIS GAUGE PRODUCED TO TIME OF DESIGN.
F40
CUTOUTS IN SKIN FOR WING JOINT, WHEEL, GUNS AND ENGINE DETERMINE DESIGN USING TWO SPARS & A SHEAR WEB FOR BENDING LOADS. LIGHT SKIN SUPPORTED BY BEADED INNER SKIN. WING THICKNESS 8.5 % SKIN THICKNESS .051
EXPERIMENTAL
HIGHER SPEEDS AND THINNER WINGS REQUIRE HIGH RIGIDITY AND DISPERSED CAP MATERIAL RESULTING IN THICK SKIN PANELS CARRYING BOTH BENDING AND TORQUE. SPANWISE STIFFENERS ARE INTEGRAL IN HIGH LOAD AREAS AND REGION OF INTEGRAL FUEL TANK. WING THICKNESS 8 % SKIN THICKNESS .100



ELECTRA WING READIED FOR FAIL-SAFE TEST



EXAMPLES OF FAIL-SAFE STRUCTURE

more frequent splicing of skin plating to avoid crack spreading.

Inward opening doors and escape hatch coverings constitute another scheme for improving pressure cabin safety. In the event a latch or hinge fails, there would be no explosive decompression.

For windows, dual panels of high strength plastic with each panel capable of taking the design pressure load are common. In some designs a third panel, used for sound insulation, will be capable of carrying the design pressure.

Some cockpit windshields will be made up of dual panels of laminated glass, each able to carry full design pressure.

Rounder and smaller cabin windows appear to have better load-carrying characteristics.

Electra Design

The Lockheed Electra is an excellent example of safety practices in current designs. There are a limited number of load paths in the Electra, hence a reduced design stress level is being used to insure against structural collapse with the severance of any single element. This is a provision to accomplish overall fail-safe characteristics.

Fail-safe features that have been incorporated in the Electra fuselage design include:

- **Doublers at all cutouts** reduce stress levels and afford multiple load paths.
- **Forged window frames** provide an integral piece to support the pane and provide reinforcement at the same time.
- **Reduced frame spacing** in the propeller plane area provides additional resistance to skin crack propagation. In the event of a blade failure, this denser structure would aid in preventing explosive decompression.
- **Dual windshield posts** instead of single posts and associated retainers are used in the cockpit.

Fail-safe features of the Electra wing include:

- **Upper and lower skin surfaces** composed of numerous 75ST extruded spanwise panels with integral stiffeners. At the root there are 9 panels, about 17-in. wide, which taper to 3 panels at the tip. This arrangement affords a number of elements so that failure of one will not cause structural collapse of the wing.
- **Spanwise panel splices** designed to transfer load from a broken panel to either adjacent unbroken panel. Without this additional strength margin, a complete failure of a spanwise splice could occur, resulting in a torsional failure of the wing.
- **Multiple element chordwise splices** used at the joint of the outer wing to the stub (center) wing. Wing loads can be carried after failure of a chordwise splice element.
- **Leg of the spar cap** along the beam web is deeper than in normal practice, to afford a shear-carrying path in the event of web failure. With such failure, shear load transfer to the caps is effected by heavy stiffeners and stronger-than-normal attachment to the caps. Spar caps have angled legs to provide beam strength across a cracked spar web.
- **Web-to-cap attachment** designed to prevent web failure in the event of cap failure. This is done by increasing the web edge distance of the attachments (rivets) to the spar caps. Also, strength of the attachments is so designed that a failure in the cap will be confined to the cap material.
- Access doors confined to the top wing surface (except at the wing tip, which is not a critical area). Limiting the access doors to the top surface keeps them in a compression surface, which is not as critical from a fatigue standpoint as the bottom (tension) wing surface.

Similar fail-safe principles are employed in the empennage.

The Electra structure will be subjected to an extensive proving program. It will be the first time that any major structural components will have been subjected to such a fail-safe testing procedure.

Fuselage extending from forward to aft pressure bulkhead will be pressurized to 6.5 psig., and simulated flight loads will be applied at the same time.

Under combined pressurization and flight loads a critical structural element of the fuselage will be severed. After

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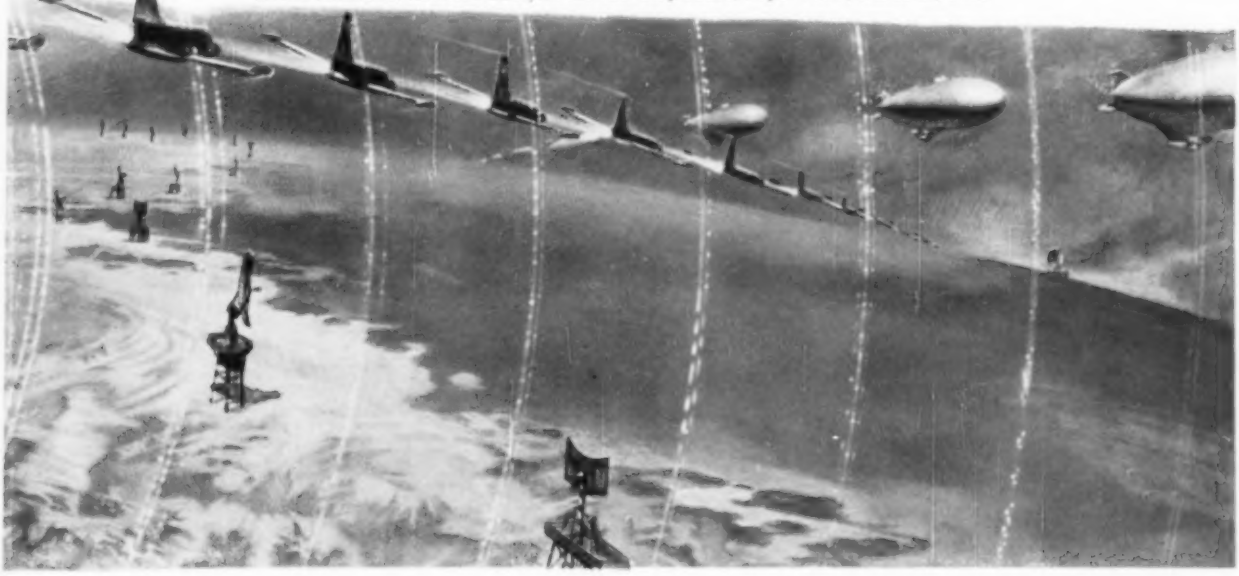

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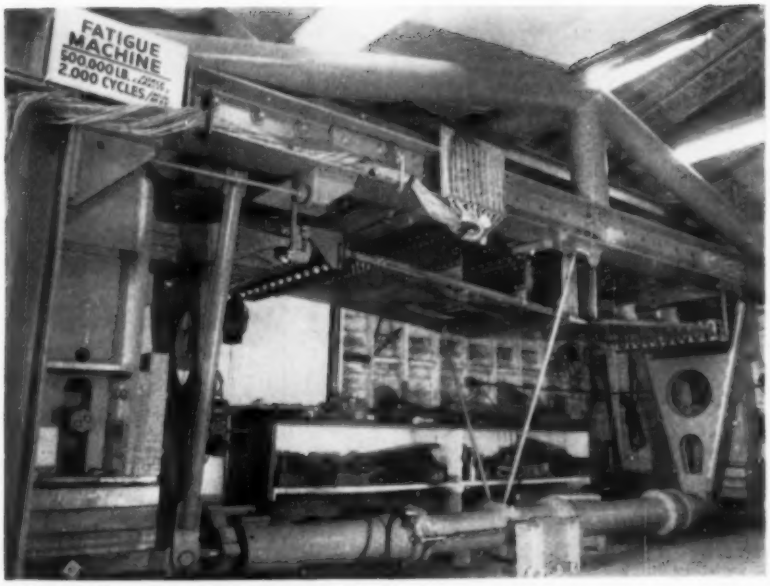

WING JOINT UNDERGOES FATIGUE TEST

successfully carrying a load with the severed element, the load will be removed and the element repaired. This same procedure will be tried with succeeding elements under consideration.

Elements chosen for severance will be those indicated by stress analysis as the more critical.

In addition to the fuselage fail-safe test, a critical section of the wing will be checked. This section will extend outward about 10 ft. from the root. It will be subjected to simulated flight loads and individual critical elements will be severed to test for fail-safety.

Military Design

Evolution into the supersonic flight regime for military aircraft has been relatively gradual, hence there have been no radical changes in structural design requirements due to increase in speed. Most significant overall change in structural arrangement has been the thinning of the airfoils and control surfaces. Designing for equivalent strength and rigidity with this thinner structure has necessitated using thicker skins and stringers and, in general, denser makeup.

One of the most difficult supersonic design problems to overcome has been the aerodynamic coupling between roll and yaw, which affects loads on tail surfaces and, in some cases, the fuselage.

This condition is caused by a general deterioration of stability about all three axes, which increases with Mach number, and requires designing for the air loads encountered at the higher angles of yaw.

This means increasing the size of the structural members in the tail and fuselage to achieve greater strength. Tail surfaces are made larger in order to increase the stability, so that the possibility of encountering high angles of yaw will be minimized.

Aeroelastic effects and flutter are playing an increased role in the design of structures for flight loads above Mach 1. It has been found that structures having sufficient strength to resist all flight and landing loads have been inadequate from flutter and aeroelastic standpoints.

When flutter and aeroelastic effects have been encountered, increased skin gages generally have taken care of both conditions through the increased torsional stiffness provided.

In most cases this automatically decreases the maximum stresses imposed by the normal loading conditions. This decrease in stress has a beneficial effect on two other related problems.

Aerodynamic Heating

When aerodynamic heating becomes a problem, the first serious consideration lies in the decreased allowable stresses. If the decrease in allowable stresses at the operating temperature does not fall below the stress level brought about by increased stiffness requirements, no structural weight penalty is paid to counteract the effects of aerodynamic heating.

Decreasing the maximum stress level through increased stiffness also increases fatigue life for the structure.

Up to about Mach 2, temperature rise is still sufficiently low so that an aluminum alloy structure is most efficient from the viewpoint of the strength/weight relationship.

Above approximately Mach 2, temperature considerations begin to influ-

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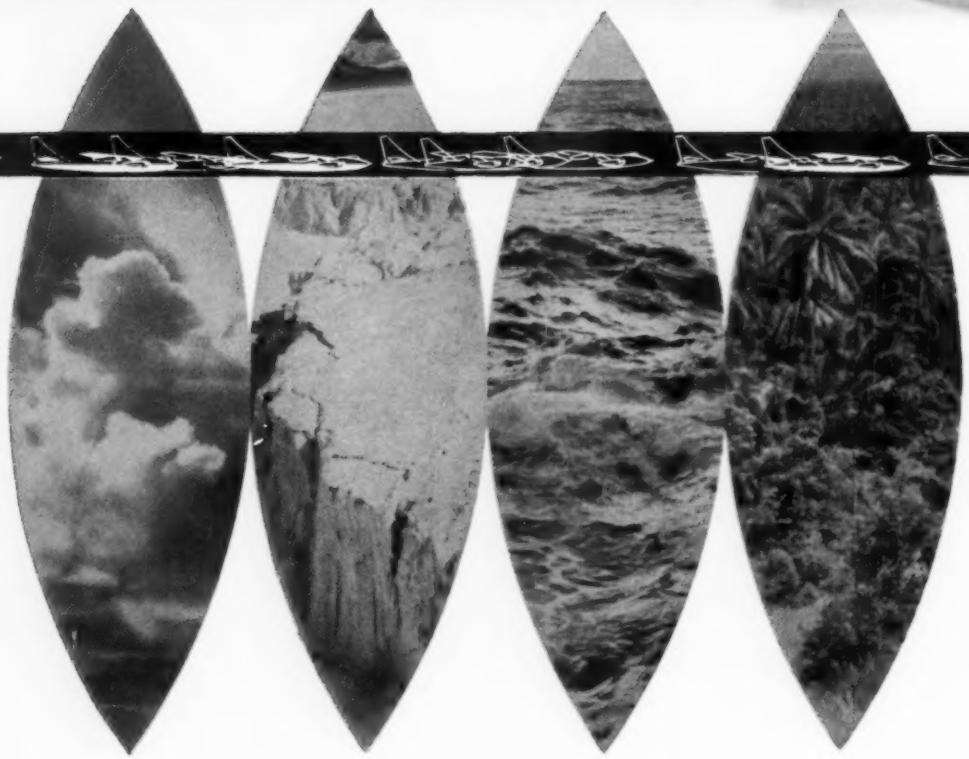

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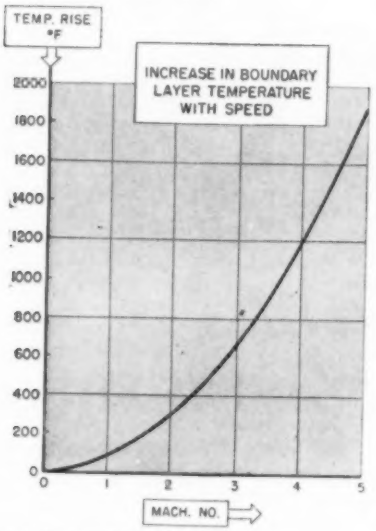


THE 'THERMAL THICKET'

ence choice of material and, depending on altitude, speed and duration of flight, may dictate the use of titanium alloys, steel, Inconel, etc.

At present, supply of these materials in production quantities of the forms and alloys necessary to provide efficient structures at the higher temperatures to be encountered may be critical.

Another difficulty is learning how to fabricate structures from these super-strength materials. Even drilling a hole is no simple procedure.

Testing Temperatures

Testing these structures under realistic temperature conditions will pose a tremendous problem. Rocket model technique, such as shooting a scale model into the atmosphere to obtain proper speed and environment may become the standard procedure, with telemetering employed to transmit the flight data.

Another technique may be the testing of structures in heated, high speed wind tunnels. This introduces scaling limitations with respect to the loads and flow of heat through the structure.

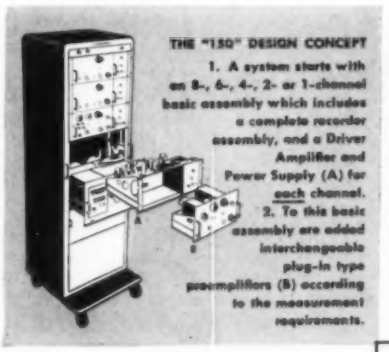
Radiant heating or oven heating of full-scale structures under load may be employed to check strength, stiffness, creep, etc., at temperature.

Both methods are sometimes employed to check behavior of structure under rapidly changing temperature.

Integral Stiffening

Integrally stiffened type of structure gradually has been adopted throughout the American aircraft industry. This trend is expected to increase. As structures become more dense because of load and temperature requirements, there will be less room in the structural cavity for bit-and-piece makeup.

One view is that use of integrally



THE "150" DESIGN CONCEPT

1. A system starts with an 8-, 6-, 4-, 2- or 1-channel basic assembly which includes a complete recorder assembly, and a Driver Amplifier and Power Supply (A) for each channel.
2. To this basic assembly are added interchangeable plug-in type preamplifiers (B) according to the measurement requirements.

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balanced or single-ended, with sensitivity of 1 mv to 2 v cm (AC), 1 mv to 2 v/mm (DC).

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Low Level Signals,

with extreme stability, high gain, and greater bandwidth than with 150-1500 Low Level Preamplifier.

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with variable resistance, differential transformer or variable reluctance transducers.

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Average Value of AC Watts in a Circuit,

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AC WATTMETER Preamp

AC Voltage Components

in phase or 180° out of phase with a reference voltage (e.g., servo error signal).

SERVO MONITOR Preamp

Higher Level Signals

where maximum sensitivity of 1 v cm, and input impedance of about 200,000 ohms are adequate.

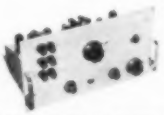
INPUT COUPLING NETWORK

DC Signals

(push-pull, single-ended or difference between two). Basic sensitivity 50 mv/cm to 50 v/cm.

DC COUPLING Preamp

RMS Values of AC Voltages, Currents,



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Rate Measuring Gyroscopes, Type K for guided missile control and homing systems and flight evaluation of military aircraft. These models measure absolute angular rates where high accuracy and superior dynamic response are essential. Linear output signal proportional to input rate within 0.25% of full scale. Withstand 100G shock in any plane and 15G vibration up to 2000 cps. Weight—3⅝ lbs. Size—5¾" long x 3.20" diameter. ***Write for Bulletin KG. 11***

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Rate Measuring Gyroscopes, Type JR for tactical weapon systems requiring less than one minute warmup. Incorporate damping compensator for constant damping ratio without heater. Linear output signal proportional to input rate within 0.25%. Withstand 50G shock, 15G vibration up to 2000 cps. Angular Momentum — 10^6 gm.-cm.^{2}/sec. Size 3⅜" long x 2.0" diameter. ***Write for Bulletin JR. 11***

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stiffened structure will continue until the aerodynamic heating problem makes the use of aluminum alloys inefficient from a strength/weight basis. Then titanium alloys and steel will enter the picture for overall use.

Initially the gages of higher strength materials used may be so thin as to require considerable stiffening by auxiliary members. At this point, to use integrally stiffened structure may be uneconomical for that reason because of the thinness of the titanium alloy or steel skin.

As the severity of the temperature problem increases, makeup is seen reverting to heavier gage integrally stiffened plate stock currently used in aluminum alloys.

Honeycomb Cores

One way to stiffen thin steel skins of future supersonic aircraft may be through the use of brazed or welded honeycomb cores. This should bring about a new form of high rigidity airframe construction with possibilities of coping with the thermal problem as well as the aeroelastic and flutter problems.

Considerable attention is being given this approach to structural arrangement for future high performance aircraft, but metal-bonded honeycomb sandwich structure is still in an experimental category at this time. Big problem lies in fabrication difficulties—obtaining panels with complete integrity of bond between core and skin and little or no distortion.

Extrusion Advantages

Of the various methods of obtaining integral skin and stringer combinations, extruding appears to have the inside track. Extrusions generally are available in long lengths, have good physical properties, and amount of rivets used is minimized.

These characteristics generally are available with milled plate and forgings, but if the design permits the use of extrusions some designers feel that these would be best structurally and also show minimum cost. For example, it would be very desirable if a wing skin could be extruded from tip to tip or from root to tip with integral stiffeners in it.

However, the design may also call for tapered skin or stringers or both. Machining the extrusions or milling the skin-stringer combination from heavy plate stock means a considerable amount of machine time. It is questionable whether enough machine capacity would be available, if all designs went to this type of integral construction.

Machining also means that the material will not be Alcladded, which results in less corrosion protection. However, other protective coatings are available, and new finishes are being developed for unclad surfaces.

Large forgings are entering the integral makeup picture in increasing volume. Structural joints in these large pieces have been one of the aircraft designer's big headaches. This difficulty is being solved with the operation of the giant forge presses under the Air Force heavy press program. Where formerly, because of size limitations, forgings had to be made in two parts and bolted together, the structural designer now has large single piece forgings available to him.

Another means of obtaining integrally stiffened structures is by chemical milling—a relatively new etch process for removing metal—which is being adopted increasingly (AW Mar. 7, 1955, p. 40).

Chemical milling isn't intended to replace all machining operations, but advantage is that it is adaptable to a wide latitude of design configurations.

The process also is adaptable for creating integral forms in titanium alloy, an important consideration since the material is hard to machine. It is possible that chemical milling may play an important role in processing integrally stiffened parts of future supersonic planes in which titanium alloys will be the structural material.

TEAMWORK

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Lucky Escape Highlights Human Factors

The lucky escape of test pilot George Smith from a disabled F-100 Super Sabre on its way to destruction spotlighted a major deficiency: an accurate stockpile of information on human factors.

The human factors field, now only a gray area on the fringe of our engineering knowledge, includes the techniques of guaranteed escape methods for pilot and crew of an airplane in trouble. It extends to the design of cockpits and controls, helmets and headrests, and to the whole of the man-machine relationship.

It is one of the biggest problem areas in aviation today and one in which luck —not good design—is still the greatest asset.

Smith was almost miraculously lucky; everything worked in his favor. All the tolerances during his marginal ejection were positive; they added up to life for him; in all previous such cases, they had been negative and added up to death.

Death as a GOR

The cold contemplation of a dead pilot has never been a General Operational Requirement, nor a pre-requisite study for designers. If it were, there would surely be a different approach to the manifold problems of relating a man to a machine.

Now from preliminary layouts to final detailing, the pilot and crew exist for the designers as dotted outlines on paper or as two-dimensional plastic cutouts. By the time these outlines have been filled by living humans, the designer has gone on to another layout.

So it is that in many cases, appreciation of the human factor comes too late. The tangled wreckage yields the answer; but before this, the designer knows or suspects. It comes as a stab of self-blame during an awful instant when he finally knows why the pilot died: not because he didn't get out, but because he couldn't get out.

That distinction between cause and effect leads to eventual understanding of the human factor in aircraft design.

Growing Knowledge

There has been a measurable growth in recognition of the human factors problems during the past few years, with the most rapid rise in recent months. Spurred on by the increasing demands of the supersonic age on man and his limited abilities, aircraft companies have sponsored—in some cases out of their own pockets—major development work in the many fields touched by this new technology.

The Air Force and Navy, both keenly aware of the human factor as reflected in accident statistics, have created special groups with facilities and personnel to tackle the problem from the military viewpoint.

CONVAIR F-102 ROCKET SLED

And both military and civilian pilots have set up a tangled, but operational communications network to pass the word about deficiencies in personal equipment, cockpit layout and airplanes.

Most encouraging note has been the initiating or increased support of original work in human factors by aircraft companies. Typical is a group at Douglas Aircraft Co.'s El Segundo plant under A. M. Mayo. Although now carrying a title relating to equipment and interiors, Mayo's group has been one of the most active in human factors. Among the specific developments have been the Navy's lightweight ejection seat system for the A4D Skyhawk and the integrated ferry jacket which eliminates most of the webbing and buckles that made life in the cockpit uncomfortable.

Northrop Aircraft's safety engineering section, whose operations were defined by engineering vice-president Edgar Schmued, has gone beyond the conventional concept of the investigation after the fact to anticipate what might happen and to see that it doesn't get a chance to. Their efforts are integrated into the design of Northrop airplanes at an early stage and they are available for consultation at all later stages.

Operations Knowledge

One suggested method to reduce the number of incipient accidents has been to integrate a knowledge of aircraft operations into the design of any aerial weapon system. Ralph Miner, of Lockheed's Guided Missile division, has been the engineering spokesman for that philosophy (AW Jan. 16, p. 43). Miner believes that air operations consciousness must become part of the every designer's ability. To do this, he proposes the creation of an operations group in the engineering organization, placed at high enough level to have the authority needed to carry through their decisions.

By understanding the operational problems, Miner says, the engineer will instinctively avoid some of the pitfalls in designing for the human factor.

Development work in pressure suits,

exposure gear and other personal equipment has been the subject of a joint effort between the engineering test pilots of Grumman Aircraft Engineering Corp., and David Clark, a manufacturer of girdles and bras.

Kicked off because most of the Grumman test flights are made over water, the team approach has paid off in a new developments in partial-pressure suits and exposure suits. Grumman also maintains an outstanding air-sea rescue operation, on standby for any emergency in the area.

The relation of the Grumman rescue operation to human factors is tenuous, but it is worth mentioning in such a discussion because of the positive effect it has on pilot morale.

Ground Tests

Simulation of the ejection process has been given tremendous impetus by ground tests made with escape systems mounted in rocket-powered test vehicles running on the highspeed track at Edwards AFB.

One of the first such series of tests was made with the fin-stabilized ejection seat system of the Douglas X-3 high-speed research aircraft. Later tests included a complete escape system of the Convair F-102A all-weather interceptor.

Speed capability of the rocket-propelled sleds is near-sonic at sea level. By matching speed and the sea level conditions (actually Edwards is at a few thousand feet), simulation of a high-altitude, supersonic bailout is made possible.

Following Smith's escape, North American set up a program to find out how he managed to survive. Part of the program was a number of ejections from the sled vehicle using an anthropomorphic dummy dressed like Smith. These runs showed that the seat and pilot actually rocked back and forth violently after ejection, rather than tumbling, and that a vigorous yawing was superimposed on top of the rocking.

Knowledge of the detailed motion of a seat-pilot combination was among the first such data to be gathered.

Dedicated Contributors

The human factors field has dedicated men. The best known is Lt. Col. J. P. Stapp, who has made many runs on the test sleds to study the response of his body to violent acceleration and abrupt deceleration. Stapp's work has done much to establish the tolerance limits of the human body to external forces, although it is reasonable to assume that no hard and fast curves will be drawn based on Stapp's runs alone.

Outstanding pitchman (there is no better word) for the human factors field is the Navy's Cmdr. George W. Hoover.

Hoover's basic purpose is to make things easier for the pilot to fly an airplane, and he proposes to do this by giving him the necessary information in a way that can not be misinterpreted. Hoover is largely responsible for the Navy's new integrated instrument and navigational system to be standardized during the next few years for all Navy aircraft. It is built around a flat television tube (AW Jan. 17, 1955, p. 17).

These are some of the better-known contributions to the field of human factors. At best they only rough in the outlines of this tremendous problem area where the payment for a mistake is measured in pilots and crews lost.

As speeds and altitudes increase, man's ability to cope with new problems must also increase. The standard attitude in the past has been that you can't change man; he's a subsonic creature and not adaptable to a supersonic age.

But there are signs that there are potentials in man that have not yet been tapped. Given certain aids, he can live and operate in the supersonic age.

It is the job of the human factors engineer and scientist to ask the questions, find the data and present the answers.

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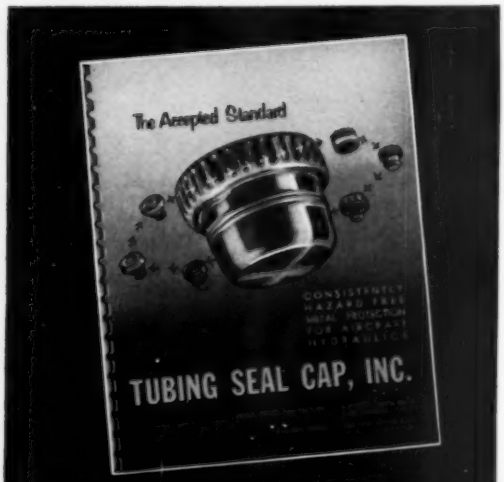

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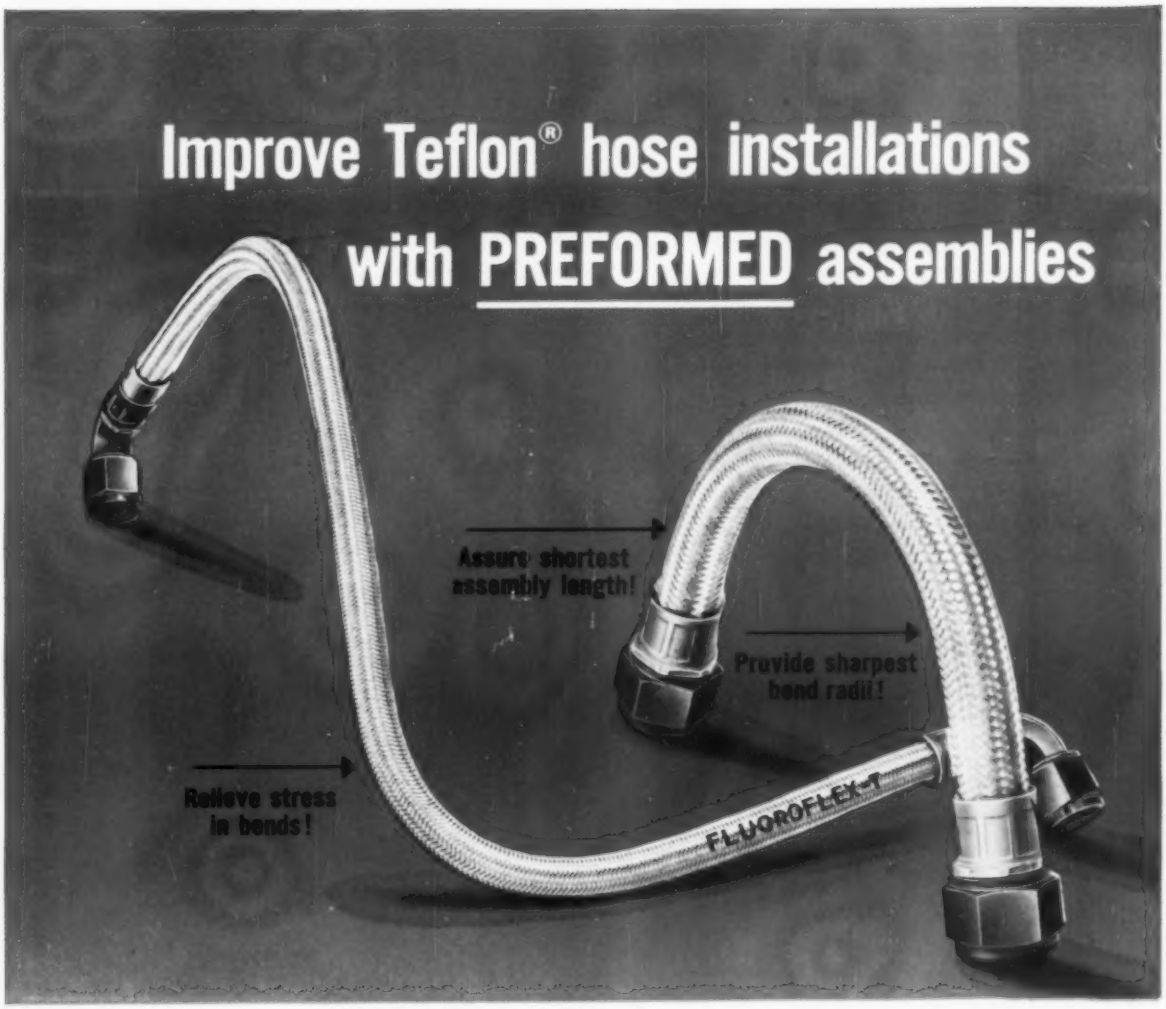

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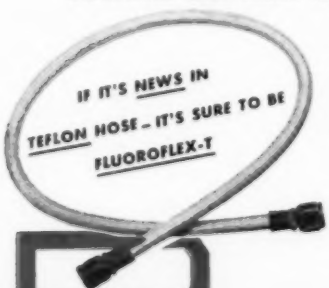

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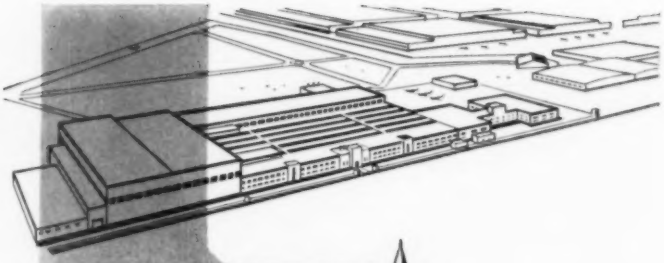

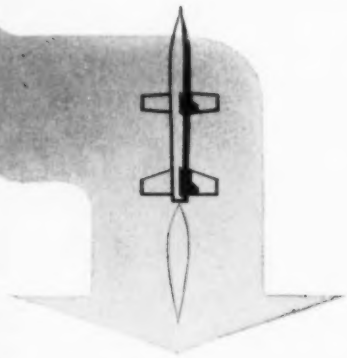

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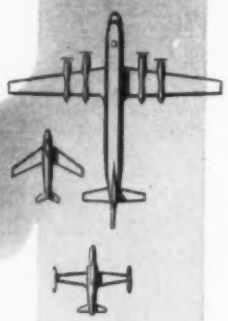

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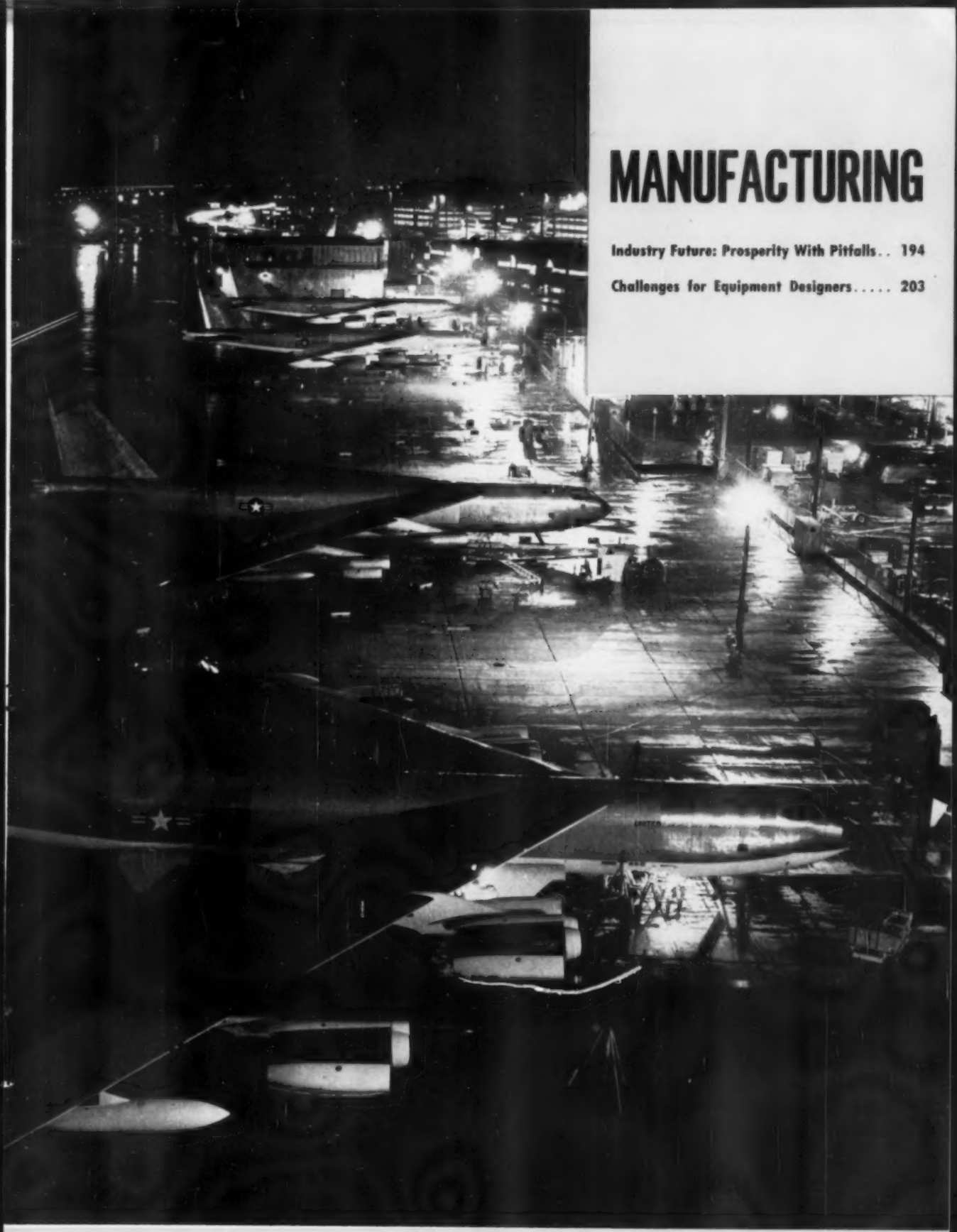

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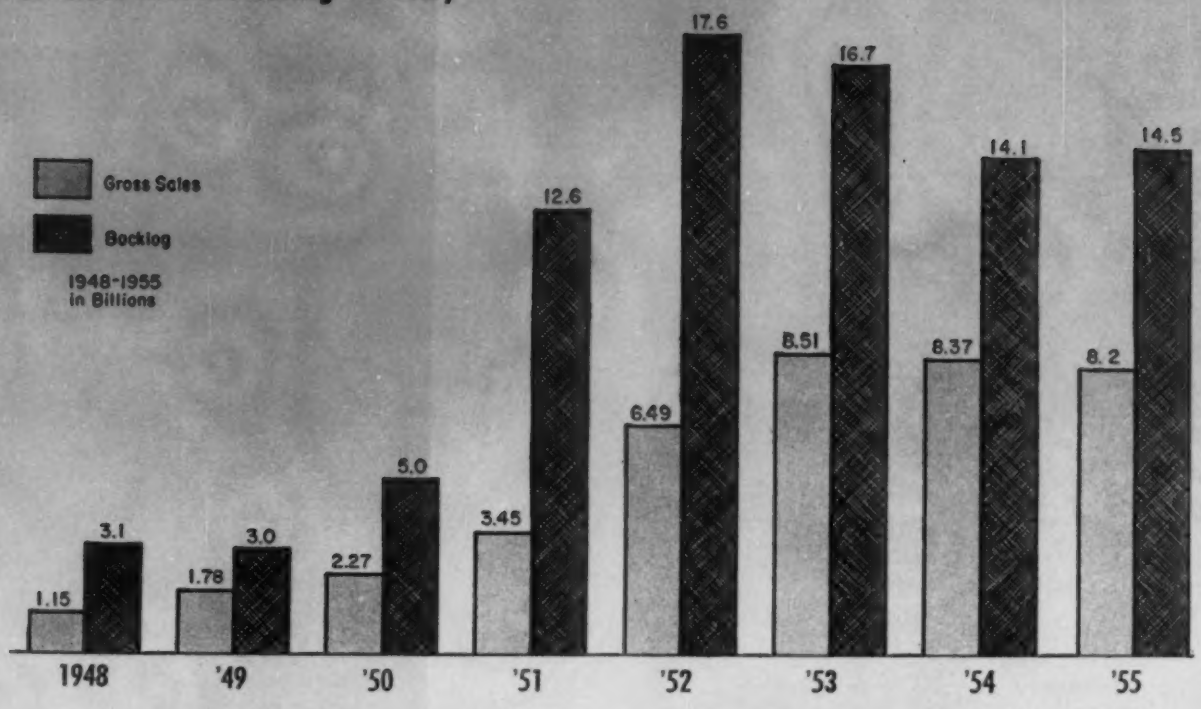


Industry Future: Prosperity With Pitfalls

By Alpheus W. Jessup

For the aircraft manufacturing industry, 1955 was another prosperous year with sales and profits at approximately the 1954 level. The future outlook, measured in terms of prospective business volume, seems to be just as bright, or even brighter. Only the uncertainties resulting from rapid technological changes and from sudden adjustment to maturity cloud the present, prosperous state of the industry.

Gross revenues of over $10 billion are forecast for 1956, including about $8.5 billion for military aircraft, missiles, avionics and supporting equipment. The remaining $1.5 billion covers commercial transport and civil aircraft sales.

Beyond 1956, higher levels are predictable. Gen. Nathan F. Twining, USAF Chief of Staff, already has indicated to the Senate Armed Services Committee that the Fiscal 1957 Federal budget does not provide the funds which the Air Force needs to maintain superiority over the Russian air force. The budget is short by about $2.5 billion of meeting America's airpower requirements for maintaining the atomic deadlock (AW Feb. 27, p. 21).

Whatever amount Congress fails to add to the Fiscal 1957 budget almost certainly will be added to the Fiscal 1958 budget. Even greater increases can be anticipated for Fiscal 1959.

Robert E. Gross, president of Lockheed Aircraft Corp., reports that studies indicate defense expenditures for aircraft and missiles will need to be "increased to between $12.5 billion and $14 billion between 1960 and 1970."

Transport Sales

Added to the military business will be an increasing volume of commercial transports. Since mid-summer 1955, airlines have placed orders of nearly $1.5 billion for only three different types of American turbine-powered airliners: Lockheed's turboprop Electra, Douglas' turbojet DC-8 and Boeing's turbojet 707. Douglas alone boasts a commercial backlog in excess of $1 billion.

Conservative forecasts by the Civil Aeronautics Administration state that air transport business will double by 1965. More likely, the doubling of 1955's business will come two to three years earlier, assuring an expanding market for American transports.

Industry Stability

This high level of aircraft business is comforting, but it does not assure a life of ease for any of the 35,000 large and small companies in the aircraft industry.

"Aircraft business will be about as unstable as ever," according to one industry representative. "Fluctuations will just take place at a much higher level than in past peacetime eras, and the magnitude for individual companies will be greater."

Technological progress will be primarily responsible, from time-to-time abetted by budget curtailment. The rate of technological obsolescence is increasing year by year for every section of the industry. The Century series of

fighter aircraft in the transonic and supersonic speed ranges are beginning to replace subsonic jet fighters. Already in the design stages are high supersonic fighters.

Obsolescence strikes engines, avionics and equipment as quickly and as indiscriminately as it does an airframe. The new high speeds and altitudes create new requirements in all categories.

Added impetus is coming from the military services, notably the Air Force. Research and procurement leaders have called upon industry to produce new, large advances in air weapons. A few miles-per-hour increase in speed or a few hundred feet in altitude performance isn't enough. Major breakthroughs are required if the U. S. is to hold its narrowing lead over the Russians.

Contract Hazards

For management, this is a serious challenge. In a day, a company could have a major portion of its military business canceled because a new, better product provided a fighting service with vastly superior combat performance. Or, business will be lost because new proposals fail to provide a true margin of improvement.

An example: In early 1954, Cambridge Corp., specializing in chryogenics, had government contracts totaling nearly $100 million and prospects for several million more. By nightfall, Cambridge's backlog had been cut to $250,000. Its government orders were wiped out in a flash because someone had discovered a better way of triggering hydrogen weapons, thus eliminating the requirements for Cambridge's equipment.

Cambridge survived through concentrated development of new business, mainly in liquid logistics equipment for transporting the common and exotic fuels used in guided missiles. But their lesson has been learned.

Budget curtailment forces questionable choices upon a military service: It can support minimum production of all the combat aircraft types it needs or it can concentrate funds on a limited number of types.

Budget Pinch

Under the Fiscal 1957 budget, USAF is reviewing its programs, aiming to stretch out some and cancel others to meet the budget limits. Going out may be projects such as the tactical bomber competition, which aimed to provide the Tactical Air Command with the kind of bomber it would need in fringe type of wars.

The Number One security industry of the country, the aircraft industry has matured rapidly. Ranked in the second hundred industries just 20 years ago, aircraft manufacturing now ranks second in employment and third in sales.

Growth resulted primarily from the huge government orders for aircraft required to fight World War II and to deter Russian aggression during the following decade. And government orders for the equipment needed to maintain the atomic deadlock will be the base for future high level of aircraft production.

From this arise most of the industry's maturity problems. The industry is a prime target for politicians willing to exploit every opportunity of impressing their tax-paying supporters. The politicians can easily make the case that the aircraft industry as a whole has waxed fat on its government business—making high profits (in relation to net worth) and accumulating net worth at rapid rate out of earnings.

Not so easy is the refutation of these charges and justification of profits.

In Defense of Profits

One of the best defenses was made recently before the House Armed Services Subcommittee by William Allen, president of Boeing Airplane Co. (AW Mar. 5, p. 20). His own company had made only 2.4% profit on sales during the period 1952 to 1955, well below the national manufacturing average. Allen noted that his company had retained a high percentage (70%) of its earnings within the company "in order to put us in position to do a better job." Since Boeing's big business is for USAF, this means a better job for U. S. security. He not only justified the modest profits made by his company for its contribution to the national security but justified an even higher rate of earnings.

As long as government accounts for the major share of aircraft business, however, the industry and its members will always face the problem of moderation in earnings and of continually telling its full financial story to the public and to Congress.

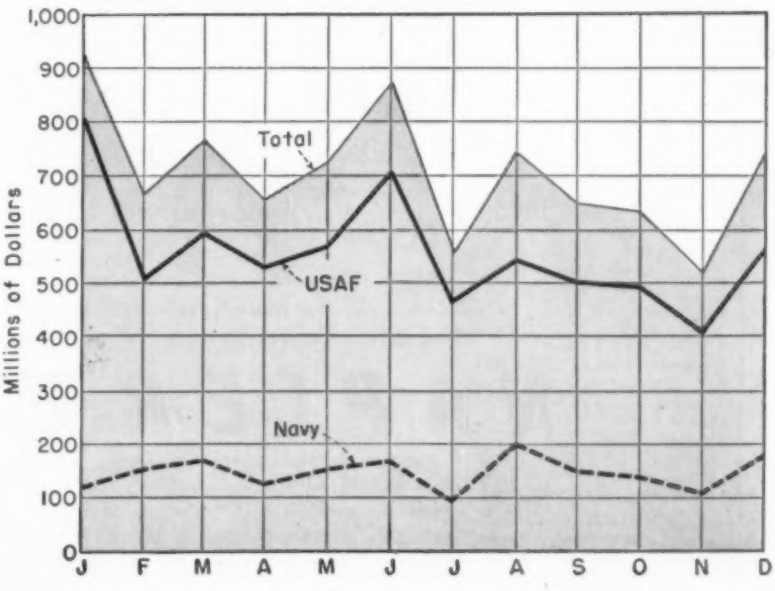
Major management tasks today revolve around the contractual relationships with the military services. Materials and tooling problems of a few years back, are no longer overridingly serious.

Besides profits and renegotiation, the major areas of concern are:

• **Concurrent spare parts.** In appropriations bills for 1956, Congress took away the Department of Defense's authority to associate funds for spare parts along with the purchase of new equipment. In the past, contracts included a certain percentage of money for spare parts, with the price and specific items to be settled later. With this authority taken away, the services substituted a commitment of intent. Since this commitment has no legal contractual value, companies contracting to deliver spare parts concurrently are gambling.

• **Protection of proprietary data.** Battle lines have been drawn between government agencies and industry over the rights of private industry to its technical know-how. With increasing frequency, defense agencies have demanded full access to a company's technical data and have even handed a company's data to another. The basic issues were defined before the National Security Industrial Association last year by R. E.

Expenditures for military aircraft in 1955



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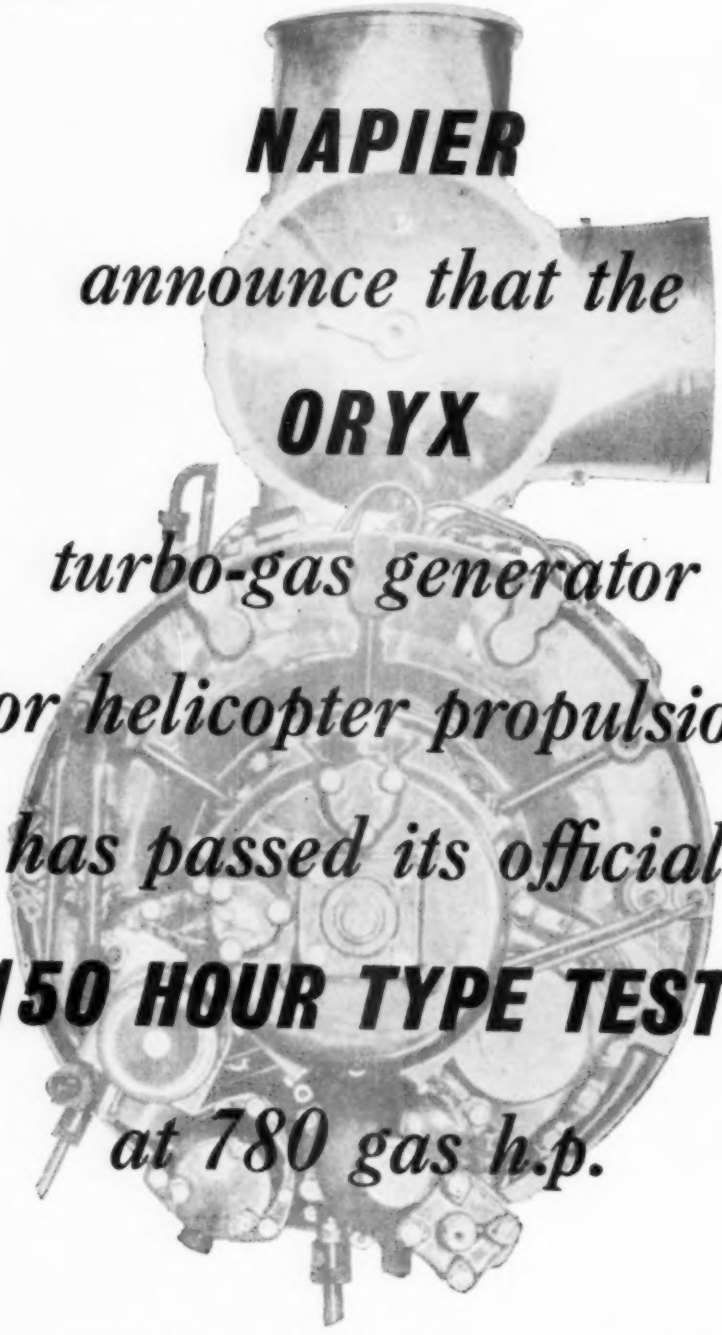

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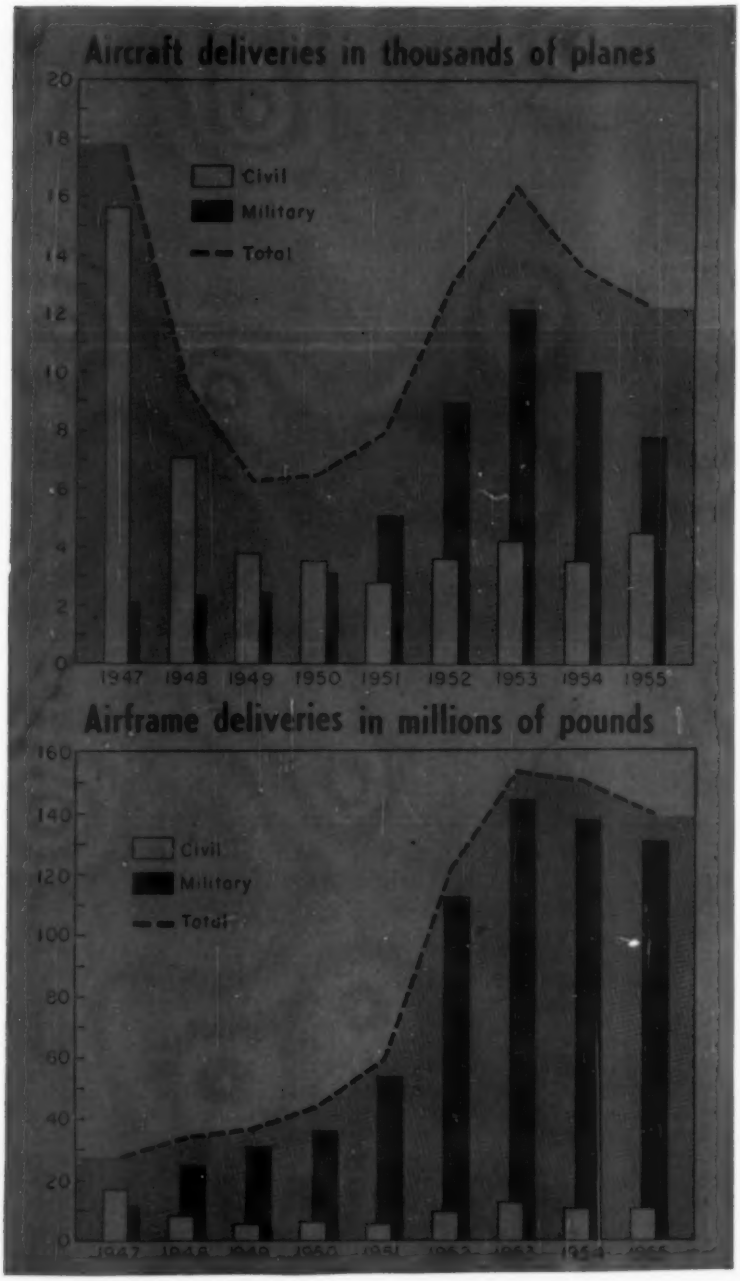

Beach of United Aircraft Corp. (AW Nov. 7, p. 21), but the industry faces a long hard fight to regain legitimate control over know-how assets.

The establishment of second sources of production for critical aircraft components also is involved in this problem. A pattern for solution to this issue was established by the Mutual Security Administration in the creation of off-shore sources for arms of our allies: First, the manufacturer with the know-how (an aircraft, for example), if he had a licensee in the foreign area, was asked to set the licensee up as a producer; second, if he did not have a licensee, he was asked to establish one with which MSA could do business; third, if unwilling to handle the transaction, the manufacturer was asked to release his patents and know-how through MSA. One example is the Lockheed-Kawasaki agreement in Japan (AW Feb. 20 p. 57). Similar steps could be taken at home.

• **Research and development.** Paradoxically, at the time that it is under Congressional fire over profits, the aircraft industry is under pressure from the armed services to invest more money in research and development. But the industry will find that it has to make

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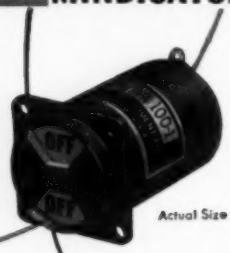

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this investment for competitive reasons. It no longer can afford to be dependent solely on places in the queues at government or independent test centers. More and more companies will find it necessary to invest in their own wind tunnels and other test facilities.

• **Manpower.** The supply of technical manpower is critical and will remain so for several years. The ever widening technological base of the American society has pushed the demand for engineers and scientists far beyond the present educational production. Management now must find more efficient ways of employing this skilled manpower, supplementing it with semi-technical personnel wherever possible and with modern computing techniques. Fortunately, production manpower is adequate to meet foreseeable needs.

Direct employment in the aircraft industry dropped to 750,900 in 1955 from the 1954 level of just over 800,000. Total wages paid by the industry were estimated at $4.1 billion.

With subcontractors added, the total employment was over 1,000,000 with salaries in excess of $5.5 billion. Hourly earnings increased from $2.08 to $2.19.

Production and Related-Worker Employment

(in thousands)

	U. S. AIRCRAFT INDUSTRY				
	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total
1955	330.0	94.5	9.3	80.1	513.9
1954	343.2	105.9	11.5	89.8	550.5
1953	347.8	126.5	13.2	89.3	576.8
1952	311.6	98.8	10.4	62.7	483.5
1951	232.3	63.7	7.6	38.3	341.9
1950	138.9	40.0	5.5	22.1	206.4
1949	130.8	38.6	5.5	19.8	194.7
1948	116.1	35.0	5.1	17.3	173.6

Total Employment

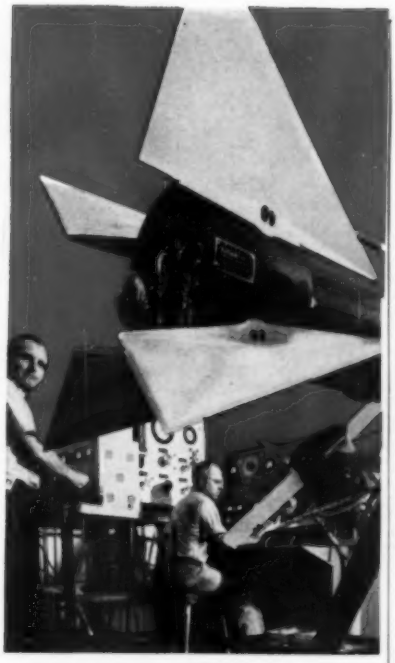
(in thousands)

	U. S. AIRCRAFT INDUSTRY				
	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total
1955	482.2	145.6	13.7	109.4	750.9
1954	497.8	166.8	16.1	125.2	805.6
1953	479.1	177.3	18.0	115.9	790.3
1952	425.9	138.8	14.5	81.6	660.7
1951	313.3	90.8	10.8	48.8	463.6
1950	188.4	55.8	8.3	29.3	281.8
1949	175.3	53.5	8.2	27.0	264.1
1948	158.0	48.6	7.7	23.3	237.7

Average Hourly Earnings of Production Workers

	U. S. AIRCRAFT INDUSTRY				
	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total Industry
1955	$2.17	$2.17	$2.18	$2.17	$2.17
1954	2.08	2.09	2.09	2.07	2.08
1953	1.99	2.03	2.03	1.99	2.00
1952	1.87	1.98	2.05	1.88	1.90
1951	1.75	1.89	1.93	1.80	1.79
1950	1.622	1.696	1.743	1.698	1.644
1949	1.548	1.603	1.630	1.611	1.567
1948	1.465	1.550	1.565	1.551	1.493

SOURCE: Bureau of Labor Statistics.



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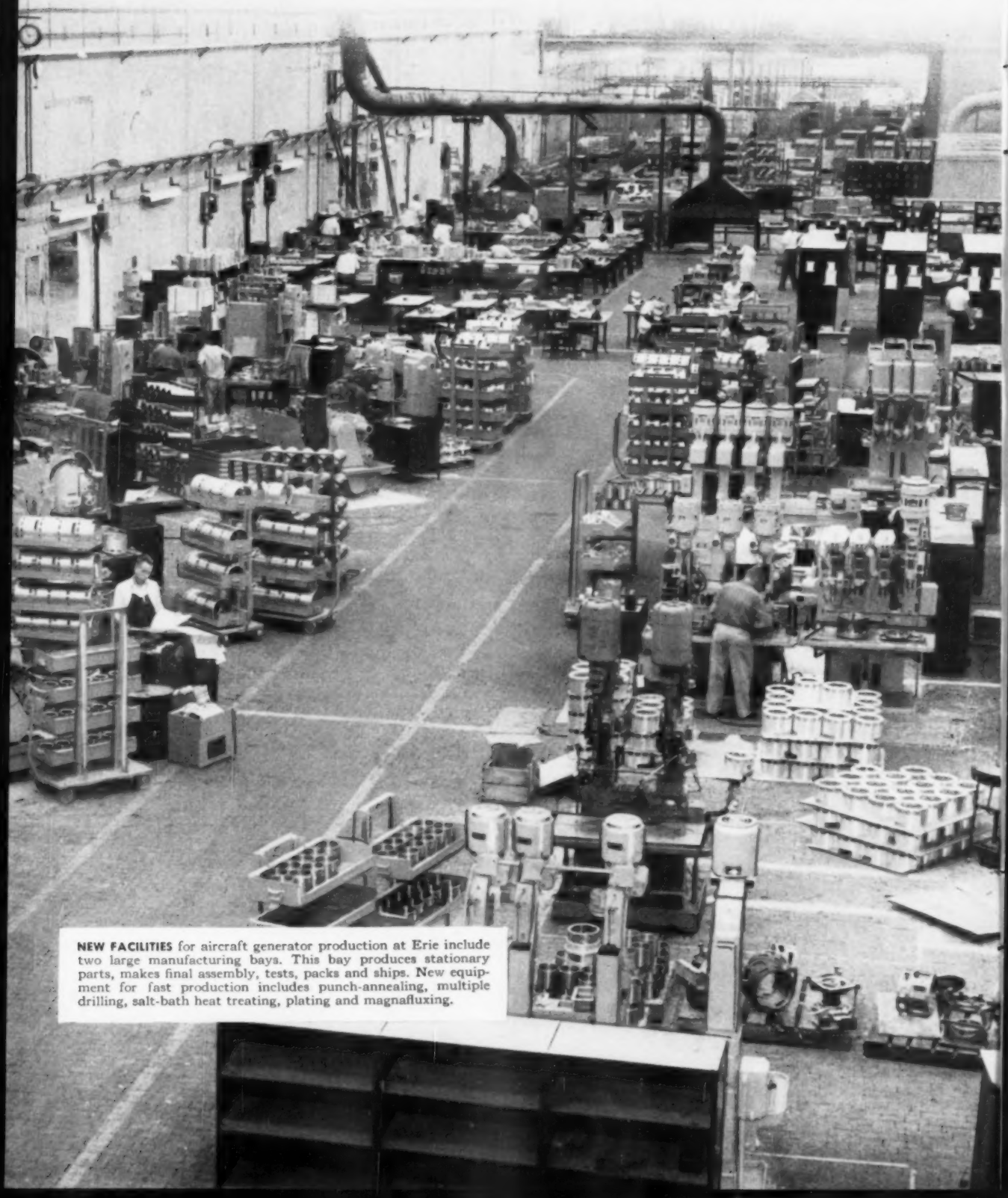
General Electric Announces:

NEW FACILITIES FOR AIRCRAFT GENERATOR PRODUCTION



NEW FACILITIES for aircraft generator production at Erie include two large manufacturing bays. This bay produces stationary parts, makes final assembly, tests, packs and ships. New equipment for fast production includes punch-annealing, multiple drilling, salt-bath heat treating, plating and magnafluxing.

FAST PRODUCTION was paramount consideration in planning of new manufacturing facilities. Parts above are stocked as close as possible to assembly area for smooth flow, quick supply. Conveyor systems are used wherever possible.

Development, manufacturing and test facilities are designed to meet aircraft industry requirements for advanced performance, fast shipment

Today, designs of aircraft electric systems now on the drawing board and the assembly line call for higher performance and lighter weight. To aid the aircraft industry in meeting these exacting demands, General Electric has consolidated its entire aircraft generator production in new modern facilities in Erie, Pennsylvania. The move to a motor and generator plant was in line with one of G.E.'s basic principles—better, more-advanced products can be made, faster delivery schedules kept, by grouping like products under one roof. Control components, too, are grouped with items of similar manufacture in new facilities at Waynesboro, Virginia, in order to provide the best design in the least time.

Both generators and controls from General Electric's new facilities will meet the increasing demands for high performance and utmost reliability in tomorrow's aircraft. At Erie new model shops speed prototype design. Two new altitude chambers subject generator performance to conditions up to 80,000 ft. Complete dynamometer facilities check machine efficiencies. At Waynesboro new drive stands, and 80,000-ft altitude chamber, humidity chamber, analog computer and others aid in control design and production.

Complete systems testing, under simulated flight conditions, will be provided by new facilities. The test facilities will assure that the most advanced ideas work together in the aircraft's electric system.

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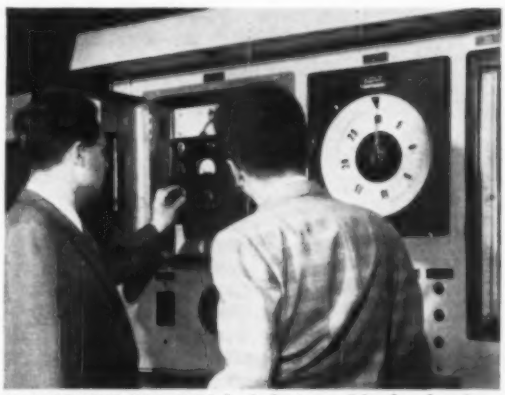

DEVELOPMENT FACILITIES include two altitude chambers at Erie, one at Waynesboro, to test components to 80,000 ft. G.E.'s aim is to evaluate continually the problems which will be encountered in high-mach, high-altitude aircraft.

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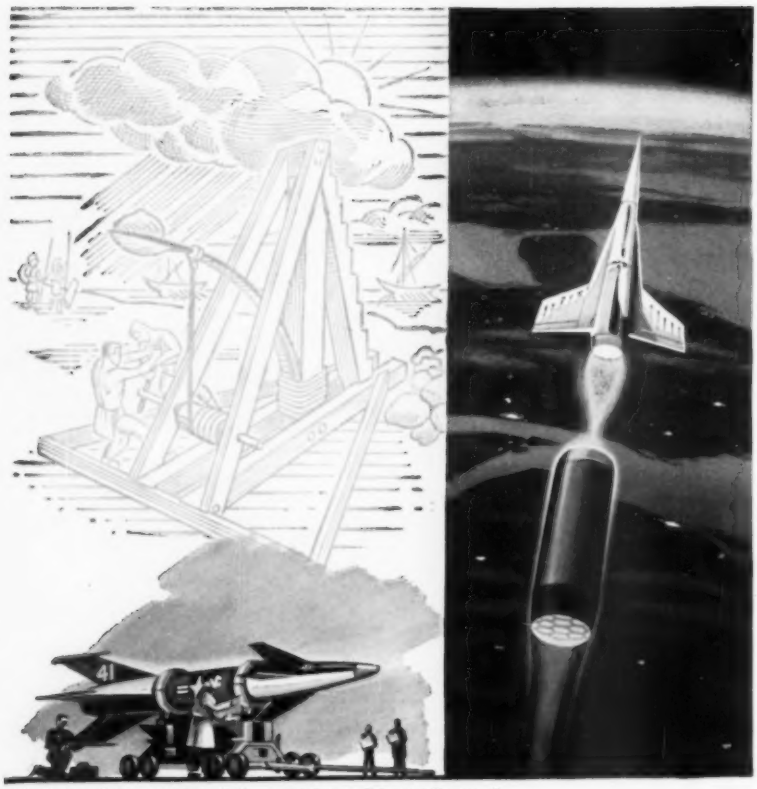

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New Speed and Altitude Conditions Challenge Equipment Designers

By George L. Christian

The thrust of military aircraft into the upper stratosphere and into the hypersonic speed range calls for radical changes in aircraft equipment if planes are to operate in these difficult flight regimes.

At the same time, as the airlines begin operating turbine-powered fleets at speeds approaching Mach 1, the commercial equipment picture also will change.

Today's cockpits contain too many handles, switches, dials and gages for a human being to cope with in tomorrow's planes. As one airframe industry official puts it: "Man is a pretty good differentiator but a poor integrator; yet we require a pilot to be primarily an integrator."

The answer is a more thorough psychological and physiological integration in the design of the pilot's "office," with important instruments concentrated in the center. A fatigued pilot's attention to peripheral instruments is likely to drop. Pictorial presentation of important information on a large screen would be ideal.

An automatic collision-warning system will be necessary on high-speed aircraft to make up for human limitations. At 20,000 ft. a plane with a 100-ft. wingspread is visible as a point. Two 900-mph. planes approaching head-on would cover this distance in about 7.5 seconds. Since it takes about four seconds from the time a pilot first recognizes a plane on a collision course until his aircraft starts taking the evasive action he has initiated, the pilot has only 3.5 seconds to spot the plane, identify the danger and initiate evasive action (AW Jan. 23, p. 48).

Canopies and Controls

The cleaner aerodynamic lines required at high speeds and the difficulty of providing large transparent areas of high-heat-resistant material may lead to the elimination of canopies. One plane now being built incorporates a periscope. Development work is underway to determine how best to present the visual image to the pilot and how large his field of vision should be.

Wright Air Development Center engineers suggest that the control stick interferes with the pilot's ability to see his instrumentation display. It also hinders ejection bail-outs.

One answer is a control seat engineered by WADC's Flight Control Laboratory. Similar to the seat designed for the Sncase Grognard (AW Jan. 14, 1952, p. 33), the movable arm rests are used to control the aircraft. Raising and lowering the arms will roll the airplane, pushing them forward or backward will cause the ship to dive or climb. For lateral control, the seat arms are articulated about midway between elbow and wrist, the forward part being movable and the after part fixed. This design is said to provide solid support for the pilot's arms and shoulders when he is subjected to high G loads.

A prototype of the control seat is almost completed and will be flight tested in a T-28.

An alternative suggestion for getting the stick out of the center of the cockpit is to provide a small control column at the pilot's side, similar to the "formation stick" used during World War II.

Pressurization and Cooling

When fighters start flying regularly at altitudes where there is virtually no air, it will no longer be practicable to bleed air from the jet compressor in the large quantities required for pressurization.

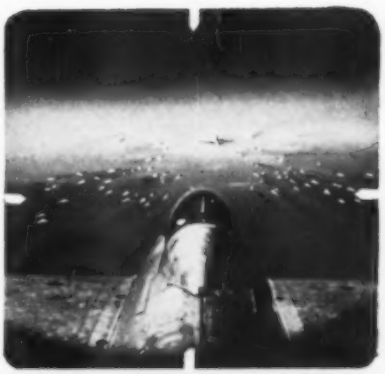
Perhaps the pilot will carry his own air and pressurization supply—possibly a compressed air bottle. Or the liquid oxygen breathing system might double as a source of pressurization. Cockpit air would be recirculated through an air-purifying dessicant canister to remove water vapor and odors.

Compressor air would be needed for cooling only, greatly reducing bleed requirements. The air would pass through an air-cycle turbine whose exhaust would go through a heat exchanger and then be dumped overboard. Handling exhaust this way instead of pushing it into the cabin allows a greater pressure drop across the turbine, raising turbine efficiency and requiring less air for a given cooling job.

WADC air conditioning experts believe vapor-cycle cooling systems will be used in very-high-speed aircraft, mainly as auxiliary coolers, absorbing cabin heat and giving it up to a heat sink—water or fuel on its way to the engines.

Ejection seats are not the answer to getting the pilot safely down from a crippled supersonic plane. Deceleration and wind blast are too severe. Current thinking is that the answer is some sort of escape capsule.

Even with a capsule, however, experts



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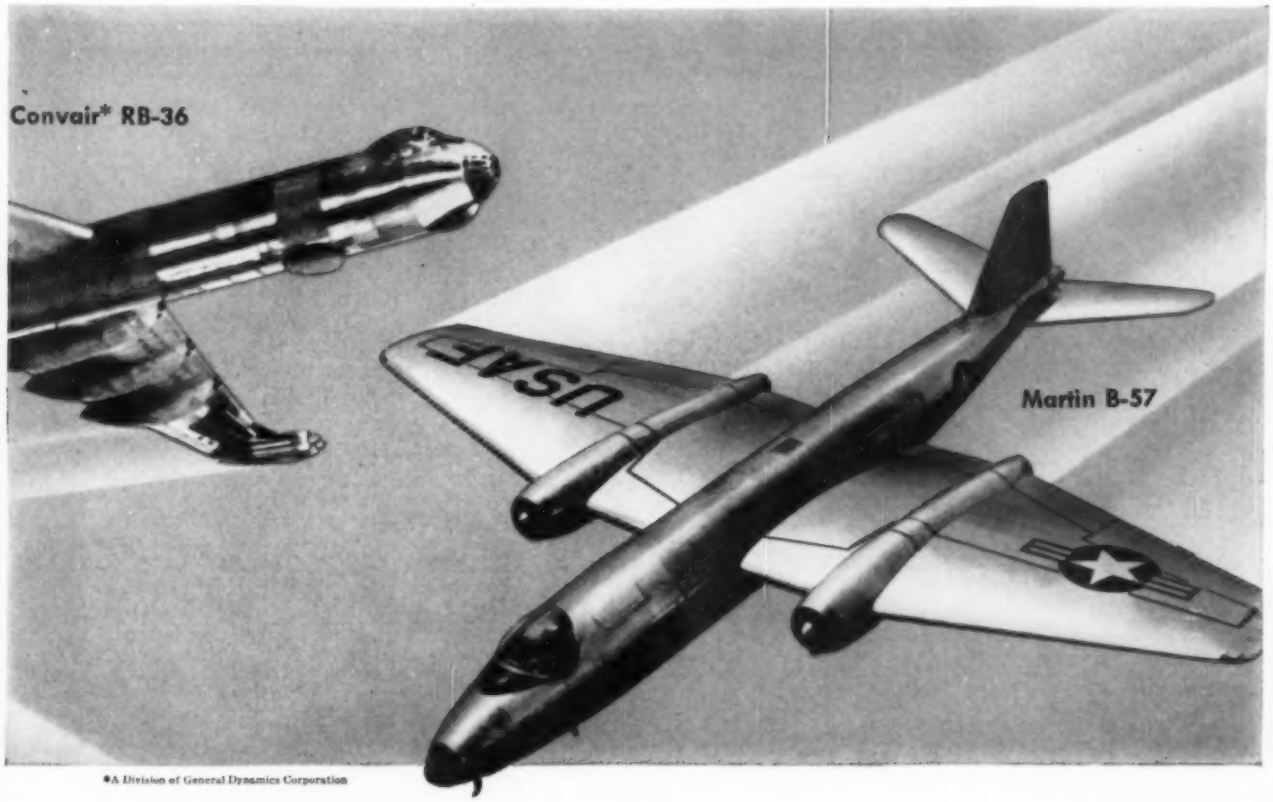

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say something will have to be done about excessive deceleration and spinning. Possibly a small booster rocket will be needed to keep the capsule from slowing down too fast and special fins will counteract the spin.

The needs of hypersonic flight are causing designers to take a long hard look at landing gear and associated equipment. It is possible these equipment items will all but disappear.

Wings already are too thin for stowing complicated retractable landing gear. It is difficult to find room for the gear in the crowded fuselage which must carry increasing quantities of avionics, fuel, cooling systems, etc. As planes fly deeper into the thermal region, the landing gear wheel wells would have to to be cooled to preserve such components as shock strut and brake seals and tires. This would mean bigger cooling systems and better sealed and insulated wheel well doors.

Higher wing loadings mean faster landings, creating a requirement for stronger struts and wheels, tires that can withstand higher ground impact loads and spin-up speeds, and brakes to absorb and dissipate increasing amounts of kinetic energy and heat.

One answer may be VTOL configurations which permit use of landing gear which is rudimentary compared with conventional gear.

Electrical Control Link

The cable control system used to transmit forces from the pilot's control column to hydraulic power servo valves may be replaced by an electrical link.

"We are already at the upper limit of allowable friction loads on existing cable control systems, particularly in the pitch axis," a Wright Air Development Center engineer told AVIATION WEEK. To minimize friction on one fighter, the cables were run through tubes in the fuel tanks, rather than through fairleads and around pulleys. This cost a few gallons of fuel.

Replacing cable with electrical wire would pay off in better aircraft performance resulting from tighter integration of the plane's flight control and stabilization system with a bonus in weight as well, says WADC. Such a change would require equipment and systems that are 100% reliable.

Improved sealing materials and techniques, and new temperature-resistant materials are pushing hydraulic system operating temperatures over the 275F mark, the accepted upper limit until recently. Temperatures of 400F may soon be common, and 700-800F limits are believed not far off. One problem is the incompatibility between most of the new seals and the new fluids.

Designers are now narrowing the clearance between static and moving

ENGINE SHROUD AND TAIL PIPE *assemblies by Lavelle help keep these Grumman Cats cool, when "full power jet heat" is on. Producing precision components to withstand tremendous stresses at high temperatures and jet speeds, demands the finest in fabrication. Experienced craftsmen, modern fabricating equipment and extensive welding facilities, enabled Lavelle to produce these stainless steel engine shroud and tail pipe assemblies to Grumman's exacting specifications in quantity . . . and deliver them on time!*

This same capacity for efficient, quantity production of intricate parts and assemblies is ready to serve you . . . when you call on Lavelle for your fabricating needs.

A new brochure describes Lavelle's specialized fabricating services. Write for a copy without obligation.

Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.

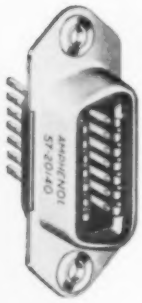
MINIATURIZATION AMPHENOL

NEW!

with INCREASED RELIABILITY!

Micro RIBBON CONNECTORS

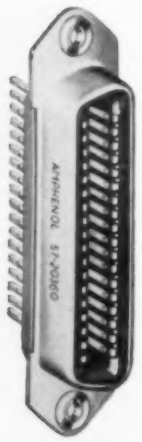
AMPHENOL's new Micro-Ribbons are the first miniature connectors to provide reduction in size with increase in reliability. Utilizing an improved 'ribbon' contact design, Micro-Ribbon connectors provide easy, smooth insertion and extraction even in blind entrance locations. There are no pins to bend or misalign but self-wiping, self-cleaning 'ribbon' contacts. Both mating contacts are active, flexing members to assure excellent double contact action at all times. Dielectric material is AMPHENOL blue diallyl phthalate, all contacts are gold-plated.



14 contacts

illustrated actual size

36 contacts



For full information on new Micro-Ribbons plus other AMPHENOL *rack & panel connectors send for new Catalog R2!*

AMERICAN PHENOLIC CORPORATION
chicago 50, illinois
AMPHENOL CANADA LIMITED *toronto 9, ontario*

AMPHENOL

parts in hydraulic units by going to lapped fits. Lapped fits require a perfectly clean system. Even "silting" (deposits caused by deterioration of fluid, filters and seals) is a problem, because the leakage of the close-tolerance valves is too low to wash away the deposits.

A suggested solution is valves with just enough tolerance to allow sufficient leakage for washing out the silt with the escaping fluid drain overboard.

Metal O-rings, another answer to sealing under high heat, work well in static and not so well in dynamic applications according to hydraulic engineers. A combination using a metal O-ring and a conventional O-ring could be used as a rod seal. The metal ring would absorb most of the pressure, but allow a small amount of leakage. The fluid at low pressure could be stopped by the conventional plastic or rubber ring.

Coiled metal tubing is replacing flexible rubber or plastic lines in very hot applications. Several coils between rigid and movable ends will absorb the limited movement caused by operation of actuating cylinders.

Swivel joints between two sections of rigid metal tubing can also be substituted for flexible lines with adequate seals at the swivel.

Above 70,000 ft., pneumatic compressors probably will not be used. The ambient air is too thin to compress efficiently. Furthermore, the jet engine will need all the air it can get, leaving none to supercharge compressor's inlet.

However, a pneumatic source will probably still be necessary, since some jobs are best accomplished pneumatically. The power source may be high-pressure air bottles or compressed air storage areas may be designed into the airframe in locations such as wing longcrons, engine supports, or landing gear struts. Use of air would probably be restricted to emergency operations (canopy or stores jettisoning). System seals and joints would have to be completely leak-free.

Another source of pneumatic power could be nitrogen or other gas in liquid form. This would require an insulated, high-strength container.

"Pseudo-pneumatics," still another source of power, makes use of the expanding gases produced by the firing of explosive cartridges to operate certain pneumatic components, such as starters.

Commercial Transports

One of the major trends in commercial turbine transports is the insistence that the planes be as independent as possible of ground servicing facilities.

One carrier will accept the weight sacrifice inherent in an airborne auxiliary power unit to get a built-in source for all electrical and/or pneumatic-hydraulic power needed when the plane's

A NEW NWL *Lift* LINE . . .

HIGH TEMPERATURE ACTUATOR

NOW hydraulic actuators operating in areas of . . .

. . . 800° F

It is now possible for you to incorporate the advantages of *hydraulics* in high temperature areas on jet engines and airframes. NWL design developments in the seals and internal configuration of the new Lift Line High Temperature Actuators are making possible such units as the pictured synchronous afterburner actuator.

SYNCHRONOUS ACTUATION . . .
. . . between two or more units is achieved through internal gearing and screw arrangements, inter-connected by flex shafting. Inter-positional relationship is maintained to thousandths of an inch. Adjustable stops, fail-safe locking, lightness of weight and selective intermediate positioning are features of this line.

ACTUATOR SPECIFICATIONS . . .
Operating Pressure: 50 to 5,000 psi; *Temperature Range:* (ambient) —65° to 500° F., (extended rod) 800° F.+, (oil) —65° to 400° F.; and *Rated Loads:* available to your specifications.

ADDITIONAL SPECIFICATIONS . . .
. . . and assistance in applying NWL engineering and quantity precision-production facilities and techniques to your high temperature problems, are available from local NWL sales-engineers and engineering project teams.

other new *Lift* line products . . .

ELECTRO-HYDRAULIC METERING VALVE

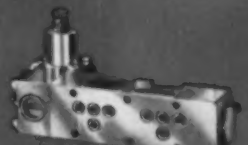
Electrical input — transformed to controlled hydraulic flow response . . . rate of response, repeatability and proportional accuracy is achieved. Developed for guided missile control systems.

UNICON

Manual, autopilot, and flight stabilization modes of control are integrated in the NWL unified flight control actuator.

HIGH TEMPERATURE SERVO ACTUATOR

Servo control actuators for operation in excess of 300° F. have been qualified and are in production.



SERVO VALVE

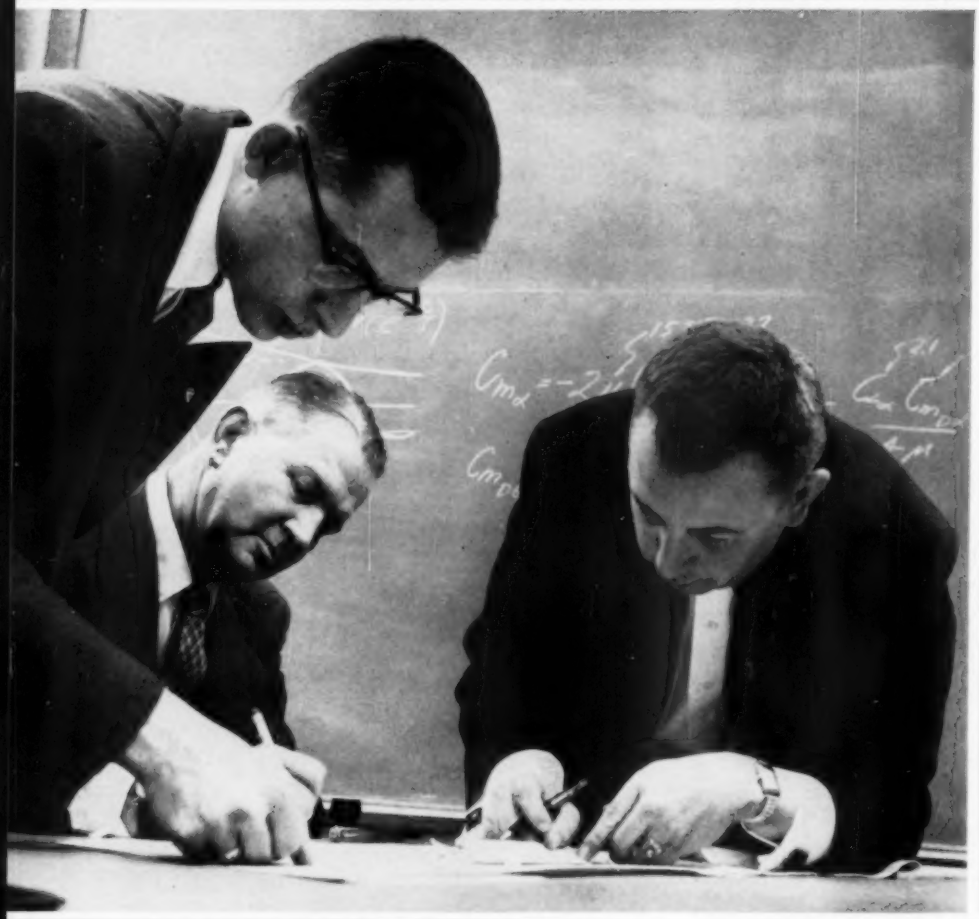
Controlled hydraulic response vs. mechanical input servo valves are available for single or dual tandem system applications.

NATIONAL WATER LIFT COMPANY
DIVISION OF CLEVELAND PNEUMATIC TOOL COMPANY
2220 PALMER AVE. KALAMAZOO, MICHIGAN

The *Lift* LINE

SCIENCE AND ENGINEERING

AT LOCKHEED MISSILE SYSTEMS DIVISION



Dr. W. S. Wunch, research specialist in aerodynamics, A. C. Ballaseyus, research engineer, and R. S. Swanson, areodynamics department manager, determine stability derivitives of a high speed missile from flight records.

THE CREATIVE APPROACH TO MISSILE SYSTEMS FLIGHT TEST ANALYSIS

The work of the Aerodynamics Department of Lockheed Missile Systems Division requires a creative approach to flight test planning and analysis. Consequently, research as well as development studies are carried on in flight determination of the performance, stability, control, flutter, aeroelastic, and aero-thermodynamic characteristics of missile airframes.

Scientists and engineers are given full scope to explore new ideas, develop new experimental and evaluation techniques. Among projects of present interest are the development of high-performance free-flight models and other advanced simulation techniques and the accompanying determination of optimum flight plan and instrumentation system characteristics.

The whole spectrum of flight test activities is covered:

1 Application and improvement of experimental planning techniques, including use of probability and statistical theory to improve test result, accuracy, reliability, and usefulness, and to decrease the expenditure of time and money.

2 Determination of range and precision requirements of systems for optimizing results in obtaining aerodynamic, structural and thermal parameters.

3 The development of mathematical and physical analogs for prediction and data for missile performance, control, flutter, aeroelastic and thermal studies.

Those possessing a high order of ability applicable to this field of endeaver are invited to write:

Lockheed

MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION

VAN NUYS, CALIFORNIA

engines are not operating. It could also be used for starting.

The APU would start automatically when the landing gear is lowered, and shut down when the gear is retracted.

Built-in APUs could save the airlines the cost of complex ground-servicing equipment which has a utilization of only 2-3 hours a day. This would also reduce the clutter of ground equipment around the new aircraft and enable the planes to get in and out of the loading area faster.

Operators say that ground units at the plane should be restricted to fuel and oil trucks (if pit refueling is not available), baggage carts, caterer's truck and passengers' loading ramp (if not built into plane).

Hot Air Requirements

Because gas turbine engines will provide great quantities of hot air, combustion heaters are not planned for the DC-8, 707 or Electra. All heating requirements will be met with air bled from the turbine's compressor section, by air heated in cabin superchargers, or electrically. The Electra's cabin heating system will consist of electric "blankets" for the cabin side walls and certain areas of the floor, and electric heaters in the cabin air ventilation ducts.

On the DC-8, hot air will blast the windshields clean, replacing wipers.

The commercial turboprop transport has brought with it several engine-propeller control innovations:

• **Single pedestal control** for all engine/propeller regimes.

• **Negative torque signal,** a control which automatically limits the amount of drag a propeller can develop in case of engine failure in flight. NTS, by controlling the prop blade angle, limits the power the propeller can absorb from the airstream to a quantity that leaves the ship fully controllable.

• **Beta range**—a range of ground operation during which the prop blade angle is indexed to the throttle position.

Freon cooling appears to be the best way to cool transport cabins, with air cycle machines topping off when heavy cooling demands are imposed on the system.

Automatic alternator synchronization will keep all alternator frequencies within desired limits.

Integrated flight instrument systems probably will be found on the instrument panels of the new planes.

Flush antennas will be used for all communications requirements, with the possible exception of the high frequency antenna.

Pre-loaded cargo containers may be tried by at least one airline buying the new gas turbine equipment. This will save manpower and loading and unloading time for baggage and cargo.

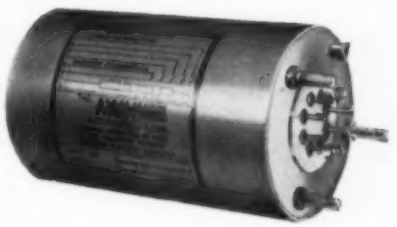
VETERAN PERFORMERS . . *preferred where performance is paramount . . .*

presented by A. W. HAYDON CO.

Miniature-Hermetically Sealed

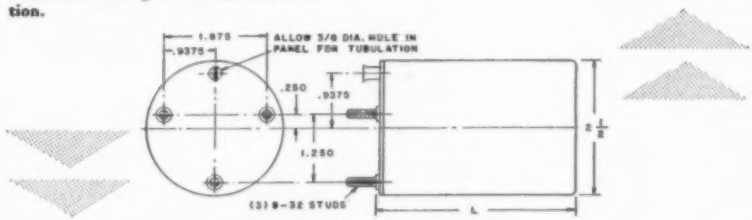
TIME DELAY RELAYS

6400, 11400, 24300 Series . . . AC, DC, 400 cycle.
Clutch-driven lever action. Time delay settings from 2 seconds to 3 hours. Where necessary, switching provided from 15-100% of overall interval.
Normal time settings within ± 10% of rating at rated voltage.
Short interval timings designed for 5600 or 5800 governed DC motors. Accuracy adjusted for 60 or 400 cycle synchronous motors, 5300 DC's, and chronometrically governed DC motors.
Repeating Accuracy specified ± 3% of overall interval.
Flexible design to meet all requirements, including multiple switches. Filtering provided for DC motors to meet MIL-I-6181 specifications.
Choice of Flange or Stud mounting. Aluminum hermetic enclosures evacuated, flushed, and filled with dry Nitrogen. Glass seal headers or AN connectors. All military environmental specifications met.
Standard unit withstands vibration of 5-55 CPS at 10g maximum acceleration.

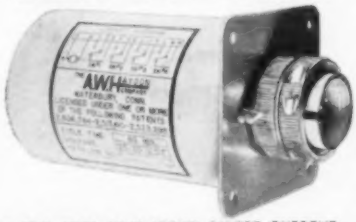


• 6400, 11400, 24300 SERIES DIRECT CURRENT, ALTERNATING CURRENT, 400 CYCLE. TIME DELAY SETTINGS FROM 2 SECONDS TO THREE HOURS • SWITCHING FROM 15-100% OF OVERALL INTERVAL CAN BE SUPPLIED • MEET MILITARY ENVIRONMENTAL SPECIFICATIONS • FILTERING TO MEET MIL-I-6181B OPTIONAL ON DC UNITS • WIRING DIAGRAM ON CASE

LENGTH "L" MAX.	6400 SERIES STANDARD D.C.	6400 SERIES GOVERNED D.C.	24300 SERIES 400 CYCLE A.C.	11400 SERIES 50,60 CYCLE A.C.
2 OR 3 SWITCHES	3 9/16	4 7/32	3 9/16	3 9/16



REPEAT CYCLE TIMERS



• 3600, 13600, 24400 SERIES DIRECT CURRENT, ALTERNATING CURRENT, 400 CYCLE • WIDE RANGE OF CYCLING TIMES AVAILABLE • ONE TO TEN SWITCHES • MEET MILITARY ENVIRONMENTAL SPECIFICATIONS • FILTERING TO MEET MIL-I-6181B OPTIONAL ON DC UNITS • WIRING DIAGRAM ON CASE

LENGTH "L"	3600 SERIES STANDARD D.C.	3600 SERIES GOVERNED DC	24400 SERIES 400 CYCLE A.C.	13600 SERIES 50,60 CYCLE AC
1 SWITCH	2 27/32	3 17/32	3	2 31/32
2 SWITCH	3 5/16	3 7/8	3 1/4	3 5/16
3 SWITCH	3 1/2	4 5/16	3 9/16	3 5/8

3600, 13600, 24400 Series . . . AC, DC, 400 cycle.
Motor-driving cam shaft principle actuates switches in accurately repeating sequence.
Motor output speeds: 10 RPM — 1 revol. per 2 hrs. in 5300 and 5600 series.
1 revol. per 40 minutes for 5800 series.
1 revol. per day for 60 cycle type.
Cutting and setting of cams tailored to your specifications.
Accommodates up to 10 switches.
DC Motors protected against reversed polarity. Filtering provided to meet MIL-I-6181 specification.
Choice of Flange or Stud mounting. Aluminum hermetic enclosures evacuated, flushed, and filled with dry Nitrogen. Glass seal headers or AN connectors for external connections. Meet military environmental specifications.
Standard unit withstands vibration of 5-55 CPS at 10g maximum acceleration.

I.R.E. SHOW BOOTH 570 & 572

WHEN TIMING POSES A PROBLEM CONSULT . . .

(General Catalog Sent on Request)

The **A. W. HAYDON *Company***

222 NORTH ELM STREET, WATERBURY 20, CONNECTICUT

Design and Manufacture of Electro-Mechanical Timing Devices

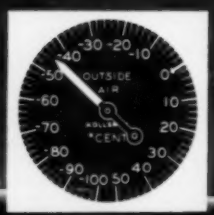
A. Gives altitude fully corrected with realistic overall errors under 50 feet at sea level and 100 feet at 40,000 feet. Needs *no* standby unit.

B. Maximum and minimum safe speeds shown on the familiar "indicated airspeed" dial, and maximum L/D for cruise controls.

C. *Corrected* Mach Number is indicated on the Machmeter Dial.

KOLLSMAN *presents . . .*

D. *True* airspeed is indicated on a miniature digital counter. *No* computing needed.



E. *True* outside air temperature, read directly on a dial *corrected* for speed. Facilitates jet stream flying.

CAREER OPPORTUNITIES

We have openings for mechanical and electromechanical engineers and senior technicians. Write us if interested.

the greatest advance in flight instrumentation since the first air transport took to the air lanes

A NEW INTEGRATED MODULAR FLIGHT INSTRUMENT SYSTEM FOR TURBINE POWERED TRANSPORTS

1. VASTLY INCREASED ACCURACY

2. IMPROVED READABILITY **3. PRESENTS CORRECTED DATA — NO COMPUTING NEEDED**

4. WITH TESTED DEPENDABILITY

The higher operating ceilings and high performance of the new Turbine Powered Transports pose new problems for pilots and Airways Traffic Control.

To simplify the pilots task and achieve better flight level control, improved flight aids are required. The Kollsman answer to this problem is the Integrated Modular Flight Instrument System.

Altitude Data — With Tested Dependability This system provides improved accuracy of altitude information. To accomplish this and still retain the high dependability of the present day Kollsman Altimeters, a mechanically operated Drum type Altimeter is used as the basic instrument. The mechanism error is removed electromechanically using a special adjustable correcting cam. Then the installation error is corrected with a fixed cam as a function of Mach Number and, if required, of Angle of Attack for pilots, co-pilots, and alternate static systems. Total altitude error through this means can be held below 50 feet at sea level and 100 feet at 40,000 feet.

Maximum and Minimum Safe Speeds Shown At All Times The system further simplifies the pilot's task by providing maximum airspeed information throughout the entire operating range of the aircraft, maximum L/D for cruise control, and minimum speed for safe low-speed landings through proportional Angle of Attack approach indication, logically displayed on the familiar IAS instrument.

Corrected Mach Number The system provides for corrected Mach Number on the separate Machmeter dial.

True Airspeed Indicated True airspeed is provided for the pilot or navigator on a miniature digital type instrument, provided with a synchro transmitter for additional remote indicators. This simplifies the problem of navigation by eliminating the need for computing true airspeed.

True Outside Air Temperature Read Directly The system provides true outside air temperature accurately corrected for speed, and incorporating a synchro transmitter for additional remote indicators. This information makes Jet Stream flying more easily accomplished by providing a simple means of detection of the sought after currents.

Ram Air Temperature For efficient jet engine performance accurate Ram Air Temperature is provided on a separate indicator.

WRITE TODAY FOR FULL TECHNICAL INFORMATION

kollsman INSTRUMENT CORPORATION

80-08 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

KOLLSMAN PRODUCES: Flight Instruments • Precision Computers and Components • Engine Instruments • Optical Systems and Components Navigation Instruments • Precision Flight Controls • Motors and Synchros • Precision Test Instruments for Aviation and Industrial Laboratories

• SPECIFICATIONS

Aircraft Industry—1955

Corporate Name	Location	Plant Area, Sq. Ft.	Employment	Sales, $	Net Income, $	Backlog, $ Jan. 1, 1956	New Production Facilities: Construction funds, 1956 $	New Production Facilities: Equipment funds, 1956 $	New Production Facilities: New plant area, sq. ft.	New R & D Facilities: Construction funds, 1956 $	New R & D Facilities: Equipment funds, 1956 $	New R & D area, sq. ft.
Aero Design & Engineering Co.	Bethany, Okla.	55,000	659	7,500,000	.....	7,000,000+						
Aerojet-General Corp.	Azusa, Cal.	674,278	6,309	69,000,000								
Solid-rocket plant	Sacramento, Cal.	351,939	950									
Liquid-rocket plant	Sacramento, Cal.	150,296	2,449									
Beech Aircraft Corp.[1]	Wichita, Kan.	1,745,000	5,933	77,075,541	3,586,510	76,200,000						
Bell Aircraft Corp.[2]	Buffalo 5, N. Y.	2,047,070	12,607	137,104,750	3,161,772	236,154,633						
	Ft. Worth, Tex.	642,930	3,000									
Bendix Aviation Corp.[1]	Detroit, Mich.	7,332,000	46,252	567,249,923	25,888,598	480,000,000			$10,000,000			
Boeing Airplane Co.	Seattle, Wash.	8,858,512	40,500	Not available								
	Wichita, Kan.	5,014,516	26,700									
Cessna Aircraft Co.	Wichita, Kan.	1,055,946	5,069	55,978,433	3,161,837	46,901,989	370,854	968,270	44,200	137,456	150,850	None
Curtiss-Wright Corp.	Wood-Ridge, N. J.											
Douglas Aircraft Co.	Santa Monica, Calif.	.....	.....	867,000,000[4]	28,250,000[4]	2,138,000,000[4]						
	El Segundo, Calif.											
	Long Beach, Calif.											
	Tulsa, Okla.											
Fairchild Engine & Airplane Corp.	Hagerstown, Md.	2,864,533	11,287	155,100,000[4]	4,000,000[4]	185,000,000[4]	2,500,000[4]			1,500,000[4]		
Engine Division	Deer Park, N. Y.											
Missiles Division	Wyandanch, N. Y.											
Stratos Division	Bay Shore, N. Y.											
Electrotechnics Division	Costa Mesa, Calif.											
Speed Control Division												
Firestone Tire & Rubber Co., Guided Missile Division	Los Angeles, Calif.			Reported in corporate statement								
General Dynamics Corp., Convair Division	San Diego 12, Calif.	10,296,099[4]	49,400[4]	.....			2,800,000[4]	1,200,000[4]	125,000[4]	3,600,000[4]	1,500,000[4]	40,000
	San Diego, Calif.	4,461,644	23,932									
	Pomona, Calif.	1,344,231	4,096	Reported in corporate statement								
	Ft. Worth, Tex.	4,344,334	20,830									
	Daingerfield, Tex.	145,890	305									
General Electric Co., Aircraft Gas Turbine Division	Evendale, Ohio	.....	.....	Reported in corporate statement								
General Motors Corp., Allison Division	Indianapolis 6, Ind.	3,289,252	10,083	Reported in corporate statement			.....	.....	.....	75,000,000[4]		1,000,000
Goodyear Aircraft Corp.	Akron, Ohio	2,500,000	10,000	Reported in corporate statement			.....	.....	.....	.....	.....	150,000
	Litchfield Park, Ariz.	900,000	2,000									
Grumman Aircraft Engineering Corp.	Bethpage, N. Y.	3,018,884	11,100	Not available								
	Peconic River, N. Y.	535,697	1,266									
Hiller Helicopters	Palo Alto, Calif.	160,000	800	Not available								
Hughes Aircraft Co.	Culver City, Calif.	2,792,000	20,875	200,000,000	.....	350,000,000						
Kaman Aircraft Corp.	Bloomfield, Conn.	200,000	952	Not available								
Lockheed Aircraft Corp.[2]	Burbank, Calif.	6,165,300	30,131	312,166,000	13,371,000[4]	802,228,000						
	Marietta, Ga.	4,285,200	19,456	167,581,000	.....	320,126,000						
Missile Systems Division	Van Nuys, Calif.	371,000	2,764	16,090,000	.....	31,632,000						
Lockheed Aircraft Service	Burbank, Calif.	550,000	4,893	25,573,000	.....	27,341,000						
Lockheed Air Terminal	Burbank, Calif.	788,300	198	2,779,000								
Lycoming Division, Avco Manufacturing Corp.	Williamsport, Pa.	929,206	2,973	Reported in corporate statement								
Glenn L. Martin Co.[2]	Baltimore 3, Md.	5,334,202	20,900	194,805,592	9,193,909	.....	.....	.....	500,000[7]			
McDonnell Aircraft Corp.[5]	St. Louis, Mo.	2,663,835	14,435	154,588,811	4,555,795	100,000,000						
North American Aviation, Inc.[1]	Los Angeles, Calif.	9,753,000	61,335	816,676,329[4]	32,349,176[4]	1,156,000,000[4]	.....	.....	989,880			
	Columbus, Ohio											
	Fresno, Calif.											
Atomics International	Canoga Park, Calif.											
Autonetics Division	Downey, Calif.											
Rocketdyne Division	Canoga Park, Calif.											
Northrop Aircraft, Inc.	Hawthorne, Calif.	2,890,076	23,125	283,462,522	11,738,764	285,960,863	1,142,000	1,300,000	40,500	5,716,000	1,459,000	330,000
	Anaheim, Calif.	350,000	1,455	.....	.....	.....	685,000	462,000	100,000			
Piasecki Helicopter Corp.	Morton, Pa.	725,000	5,930	N. A.	N. A.	125,000,000	.....	.....	.....	.....	.....	2,500
Piper Aircraft Corp.	Lock Haven, Pa.	286,000	1,603	16,812,804	1,400,826	10,000,000	463,000	447,000	71,000	.....	.....	.....
Republic Aviation Corp.[2]	Farmingdale, N. Y.	2,813,000	18,000	225,961,164	12,312,873	600,000,000	.....	.....	.....	6,000,000	.....	424,000
Ryan Aeronautical Co.	San Diego 12, Calif.	850,000	4,000	41,500,000	1,550,000	50,000,000			$1,600,000			
Stroukoff Aircraft Corp.	W. Trenton, N. J.	200,000	525	3,500,000	N. A.	9,000,000	250,000	.....	.....	.....	.....	.....
Temco Aircraft Corp.	Dallas, Tex.	1,916,471	7,196	78,200,000	3,100,000	96,000,000						
United Aircraft Corp.[3]	E. Hartford, Conn.	9,520,000[4]	...	151,932,033[4]	22,732,949[4]	1,275,000,000[4]						
Pratt & Whitney Aircraft Division	E. Hartford, Conn.	6,000,000	34,000									
Hamilton Standard Div.	Windsor Locks, Conn.	1,000,000	7,500									
Sikorsky Aircraft Div.	Bridgeport, Conn.	1,500,000	8,400									
Chance Vought Aircraft, Inc.[3]	Dallas, Tex.	2,450,000	12,000	93,762,657	2,794,099	162,000,000						
Westinghouse Electric Corp.	Pittsburgh, Pa.											
Air Arm Division	Baltimore, Md.	312,000										
Aviation Gas Turbine Div.	Kansas City, Mo.	2,500,000										

[1] Financial data reported for Fiscal Year ending 9/30/55
[2] First nine months of 1955
[3] Estimated or approximate
[4] Total for all divisions
[5] Financial data reported for Fiscal Year ending 6/30/55
[6] For period from 1956 to 1959
[7] New facility in Denver

Source: Industry reports to AVIATION WEEK

U.S. Missiles and Pilotless Aircraft

Basic Missile Data					Physical Data				Powerplant	Launcher	Performance		Current Status			Remarks
Category	Name	Designation	Manufacturer	Cognizant service	Overall length, less booster, ft.	Overall span of fins or wings, ft.	Body diameter, ft.	Takeoff weight, less booster, lb.	Manufacturer, type and designation	Manufacturer, type and designation	Maximum speed, Mach number	Maximum range, mi.	Research	Development	Production	Service use	
Air-to-air	Ding-Dong	.....	Douglas	USAF	....	....	....	.....	1 NAA lpr.	.....	....	....	√	√			Nuclear warhead
	Falcon	GAR-98	Hughes	USAF	6.5	2	0.5	112	1 Thiokol spr.	None	....	....			√		Tested on Convair F-102
	Sidewinder	XAAM-N-7	Philco	Navy	....	....	....	.....	.....	.....	....	....		√	√		
	Sparrow 1	XAAM-N-2	Douglas	BuAer	....	....	....	.....	1 Aero. spr.	None	3	....		√	√	√	Sperry is prime contractor
	Sparrow 2	XAAM-N-3	.....	BuAer	....	....	....	.....	1 Aero. spr.	.....	....	....		√			
	Sparrow 3	XAAM-N-4	.....	BuAer	....	....	....	.....	1 Aero. spr.	.....	....	....		√			
Air-to-surface	Bullpup	XASM-N-7	Martin	Navy	11	....	1	.....	1 Aero. spr.	None	....	....	√	√			Canard airframe
	Dove	XASM-N-4	East. Kodak	Navy	....	....	....	.....	.....	.....	....	....			√		
	Rascal	GAM-63	Bell Aircraft	USAF	20	....	4.5	.....	3 Bell lpr.	None; air-launched	1.5	100		√	√		Bell has systems contract
Air-to-underwater	Petrel	XAUM-N-2	Fairchild	BuOrd	....	....	....	.....	1 Fair. J44 tj.	None; air-launched	0.7	....			√		For anti-sub use
Anti-missile	.....	.....	Bell Labs.	Army	....	....	....	.....	.....	.....	....	....	√				
	.....	.....	Convair	USAF	....	....	....	.....	.....	.....	....	....	√				
	.....	.....	North American	USAF	....	....	....	.....	.....	.....	....	....	√				
Surface-to-air	Bomarc	IM-99	Boeing	USAF	....	....	....	5,000	2 Mar. rj.	1 Aero. lpr.	2.5	....	√	√			
	Hawk	.....	Raytheon	.....	....	....	....	.....	.....	.....	....	....		√	√		
	Loki	.....	East Coast	ArmyOrd	....	....	25	.....	1 GC spr.	None	....	....			√		
	Nike 1	XSAM-A-7	Douglas	ArmyOrd	20	....	1	.....	1 Aero. lpr.	1 Herc. spr.	2.0	18		√	√	√	More than 100 sites near 13 cities
	Talos	XSAM-N-6	McDonnell	BuOrd	....	....	....	.....	1 ramjet	.....	....	....		√	√		Also Talos L, Talos W
	Terrier 1	XSAM-N-7	Convair	BuOrd	....	....	....	.....	1 lpr.	1 spr.	2.5	20			√	√	
	Terrier 2	.....	Convair	BuOrd	....	....	....	.....	1 lpr.	1 spr.	....	....	√	√			Homing version
	Tartar	.....	Convair	BuOrd	....	....	....	.....	.....	.....	....	....	√	√			
Surface-to-Surface	Atlas	SM-65	Convair	USAF	....	....	....	.....	NAA lpr.	.....	....	....	√	√			Intercontinental ballistic missile
	Corporal	XSSM-A-17	Firestone	ArmyOrd	40	....	2.5	12,000	1 JPL lpr.	None	....	....			√	√	Originated at JPL
	Dart	.....	ADC	ArmyOrd	....	....	....	.....	.....	.....	....	....	√	√			
	Honest John	.....	Douglas	ArmyOrd	21	8	2.5	.....	1 Herc. spr.	None	....	....		√	√	√	Unguided; range comparable to long-range artillery
	Lacrosse	.....	.....	ArmyOrd	....	....	....	.....	1 spr.	.....	....	....			√		Close-support missile
	Little John	.....	Douglas	ArmyOrd	....	....	....	.....	1 spr.	None	....	....	√	√			Short-range Honest John
	Matador	TM-61A	Martin	USAF	39.5	28.8	4.5	12,000	1 All. J33-A-37 tj.	1 spr.	0.9	600		√	√	√	TM-61B is development
	Navaho	SM-64	North American	USAF	....	....	....	.....	2 Wr. rj.	NAA lpr.	3.0	....		√			At least three versions
	Redstone	.....	Chrysler	ArmyOrd	60	12	5.5	.....	1 NAA lpr.	None	....	....		√			Tactical missile
	Regulus	XSSM-N-8	Chance Vought	BuAer	33	21	4.5	.....	1 All. J33-18A tj.	2 Aero. spr.	....	....			√	√	
	Sergeant	.....	.....	ArmyOrd	....	....	....	.....	1 spr.	.....	....	....	√	√			Corporal replacement
	Snark	SM-62	Northrop	USAF	32	....	4.5	.....	1 All. tj.	Sled launcher	0.9	....		√	√		Development has P&W J57tj.
	.....	IRBM	Chrysler	ArmyOrd BuOrd	....	....	....	.....	lpr.	.....	....	....	√	√			Intermediate range ballistic missile
	.....	IRBM	Douglas	USAF	....	....	....	.....	lpr.	.....	....	....	√	√			Intermediate range ballistic missile
	.....	ICBM	Martin	USAF	....	....	....	.....	lpr.	.....	....	....	√				Intercontinental range
Target	.....	KDB-1	Beech	BuAer	13.5	12.0	1.5	600	1 McC.	Van Zelm AT-3	0.5	322		√			
	.....	YQ-1B	Radioplane	USAF	18.3	14.4	2.5	1,805	1 Con. J69-T-19	A-1 catapult	....	....	√	√			
	Firebee	Q-2A	Ryan	USAF	17.3	11.2	....	1,848	1 Fair. J44-R-20 tj. 1 Con. J69-T-19 tj.	1 Aero. X102F2 spr.	0.9	770			√	√	Also XM-21 (Army) and KDA-1 (Navy)
	.....	OQ-19D	Radioplane	USAF	12.3	11.5	.....	.....	1 McC. O-100-1	M3 spr.	0.3	....			√	√	Also Navy KD2R-5 and Signal Corps RP-71
	.....	RP-77C	Radioplane	None	12.9	11.8	1.7	830	1 Lyc. SO-360-M	1 spr.	0.5	....		√			Also RP-77B with McCulloch engine, RP-77D with Boeing 502-10 t'prop.
Research	Aerobee	RTV-A-1A	Aerojet	USAF Navy SigCor	20.0	5.2	1.3	1,140	1 Aero. lpr.	1 Aero. spr.	4.8	....			√	√	
	Aerobee-Hi	AJ11-6 AJ11-18	Aerojet	USAF Navy	23.0 23.0	5.2 5.2	1.3 1.3	1,310 1,200	1 Aero. lpr. 1 Aero. lpr.	1 Aero. spr. 1 Aero. spr.	6.5 6.5	....		√		√	√

Abbreviations:

ADC—Aerophysics Development Corp.
Aero—Aerojet-General Corp.
All—Allison Division
ArmyOrd—Army Ordnance
BuAer—Navy Bureau of Aeronautics
BuOrd—Navy Bureau of Ordnance
Con—Continental Motors Corp.
Fair—Fairchild Engine Division
GC—Grand Central Aircraft
Herc—Hercules Powder Co.
ICBM—Intercontinental ballistic missile
IRBM—Intermediate range ballistic missile
JHU/APL—Johns Hopkins Univ. Applied Physics Lab
JPL—Jet Propulsion Lab. CalTech
lpr—Liquid-propellant rocket
Lyc—Lycoming div. of Avco
Mar—Marquardt Aircraft Co.
McC—McCulloch Motors
NAA—North American Aviation, Inc.
NRL—Naval Research Lab
P&W—Pratt & Whitney Aircraft Division
rj—Ramjet
RMI—Reaction Motors, Inc.
R-R—Rolls-Royce, Ltd.
SigCor—Signal Corps
spr—Solid-propellant rocket
tj—Turbojet
USAF—United States Air Force
Wr—Wright Aeronautical Division

U. S. Military Aircraft

Manufacturer	Military Designation	Military name	Primary mission	Number in crew	Overall span, ft.	Overall length, ft.	Overall height, 3-pt., ft.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross wt., lb.	Maximum gross wt., lb.	Number, manufacturer, model and max. rating
Beech Aircraft Corp. *Wichita 1, Kan.*	L-23B	.....	Lt. trans.	6	45' 3"	31' 6"	11' 4"	277	4,015	6,000	.....	2 Lyc. GO-435-C2 @ 2
	T-34A	Mentor	Trainer	2	32' 10"	25' 11"	9' 7"	178	2,170	2,900	.....	1 Con. O-470-13 @ 225
Boeing Airplane Co. *Seattle, Wash.*	B-47E	Stratojet	Med. bomb.	3	116'	107'	28'	.....	.....	.....	200,000	6 GE J47-GE @ 6,000 l
	B-52	Stratofortress	Heavy bomb.	6	185'	156'	48'	.....	.....	.....	350,000	8 P&W J57 @ 10,000 l
	KC-97G	Stratofreighter	Tanker-trans.	5	141' 3"	110' 4"	38' 3"	1,768	78,884	153,000	175,000	4 P&W R4360-59B @ 3
	KC-135	Stratotanker	Tanker-trans.	..	.....	.....	.....	.....	.....	.....	.....	.....
Cessna Aircraft Co. *Wichita, Kan.*	XT-37	.....	Trainer	2	33' 0"	27' 1"	9' 10"	.....	.....	5,600	.....	2 Con. J69 @ 900 lb.t.
	OE-2	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	1 Con. @ 265 hp.
Convair Division, GDC *San Diego, Calif.*	B-36J	.....	Heavy bomb.	15	230'	162' 1"	46' 9"	4,772	.....	.....	400,000+	6 P&W R4360-53 @ 3,5
	XB-58	Hustler	Bomber	..	.....	.....	.....	.....	.....	.....	.....	4 GE J79-GE-1
	F-102A	.....	A-W inter.	1	38' 2"	68' 3"	18' 2"	.....	.....	.....	.....	1 P&W J57-P-23 @ 10,0
	TF-102A	.....	Trainer	2	38' 2"	63' 4"	18' 0"	.....	.....	.....	.....	1 P&W J57-P-23 @ 10,0
	T-29C	Flying Classroom	Trainer	4	91' 9"	74' 8"	27' 3"	817	29,000	43,575	43,575	2 P&W R2800-99W @
	C-131A	Samaritan	Air evac.	3	91' 9"	74' 8"	27' 3"	817	29,000	43,575	43,575	2 P&W R2800-99W @
	C-131B	.....	Test bed	..	105' 4"	79' 2"	28' 2"	920	29,248	47,000	47,000	2 P&W R2800-99W @
	YC-131C	.....	Exp. trans.	3	105' 4"	79' 2"	28' 2"	920	.....	.....	47,000	2 All. YT56-A3 @ 3,250
	C-131D	.....	Transport	3	105' 4"	79' 2"	28' 2"	920	29,600	.....	46,500	2 P&W R2800-CB16 @
	XFY-1	Pogo	Fighter	1	25' 8"	34' 10"	23' 11"	.....	.....	.....	.....	1 All. T40 @ 5,850 hp.
	XF2Y-1	Sea Dart	Fighter	1	.....	.....	.....	.....	.....	.....	.....	2 West. J46 @ 6,000 lb.
	R3Y-2	Tradewind	Transport	6	145' 9"	139' 8"	51' 5"	.....	.....	.....	160,000	4 All. T40-A-10 @ 5,50
	R4Y-1	.....	Transport	3	105' 4"	79' 2"	28' 2"	920	30,684	47,000	47,000	4 P&W R2800-52W @
Douglas Aircraft Co., Inc. *Santa Monica, Calif.*	B-66B	.....	Tac. bomber	3	72' 6"	75' 2"	23' 7"	780	42,086	78,000	83,000	2 All. J71-A-11 @ 10,0
	RB-66B	.....	Night PR	3	72' 6"	75' 2"	23' 7"	780	42,797	70,000	83,000	2 All. J71-A-11 @ 10,0
	C-124C	Globemaster 2	Cargo trans.	5–8	174' 2"	130' 0"	48' 4"	2,506	101,165	185,000	194,500	4 P&W R4360-63A @ 3
	C132	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	.....
	C-133A	.....	Cargo trans.	4–7	179' 8"	152' 8"	48' 3"	2,673	110,881	255,000	282,000	4 P&W T34-P-3 @ 5,7
	AD-5	Skyraider	Attack	1–3	50'	39'	15' 10"	400	.....	19,000	.....	1 Wr. R3350 @ 2,700 h
	A3D	Skywarrior	Attack	3	72' 6"	73' 6"	22' 9"	.....	.....	70,000	.....	2 P&W J57
	A4D	Skyhawk	Attack	1	27' 6"	39' 1"	15' 2"	.....	.....	15,000	.....	1 Wr. J65-W-4
	F4D	Skyray	Interceptor	1	33' 6"	44' 4"	13' 0"	557	.....	25,000	.....	1 P&W J57
	F5D1	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	.....
Fairchild Aircraft Div. *Hagerstown, Md.*	C-119G	Flying Boxcar	Assault trans.	5	109' 3"	86' 6"	26' 3"	1,447	39,920	64,000	74,400	2 Wr. R3350-85 @ 3,50
	C-123B	Provider	Assault trans.	2	110'	76' 3"	34' 1"	1,223	30,812	56,500	60,000	2 P&W R2800-99W @
Grumman Aircraft Eng'g. Corp. *Bethpage, L. I., N. Y.*	F9F-8	Cougar	Fighter	1	34' 6"	41' 7"	12' 3"	.....	.....	.....	.....	1 P&W J48-P-8 @ 7,20
	F11F-1	Tiger	Fighter	1	31' 8"	40' 10"	12' 9"	.....	.....	.....	.....	1 Wr. J65-W-6
	S2F-1	.....	Anti-sub.	4	69' 8"	42' 3"	16' 3"	.....	.....	.....	.....	2 Wr. R1820-82 @ 1,52
	TF-1	.....	Cargo trans.	2	69' 8"	42' 0"	16' 3"	.....	.....	.....	.....	2 Wr. R1820-82 @ 1,52
	SA-16A	Albatross	Rescue	6	80'	62' 4"	24' 5"	.....	24,000	.....	34,000	2 Wr. R1820-76A @ 1,
	SA-16B	Albatross	Rescue	6	96' 6"	62' 4"	26' 11"	.....	25,000	.....	35,000	2 Wr. R1820
Lockheed Aircraft Corp. *Burbank, Calif.*	F-104A	.....	Fighter	1	22'	.....	.....	.....	.....	15,000	.....	1 GE J79-GE-3
	T-33A	.....	Trainer	2	38' 11"	37' 8"	11' 8"	238	8,400	11,700	15,000	1 All. J33-A-35 @ 5,20
	C-121C	Super Constellation	Transport	5–15	123' 5"	116' 2"	24' 9"	1,654	73,113	.....	133,000	4 Wr. R3350 @ 3,250 h
	EC-121D	Super Constellation	Early warning	32	123' 5"	116' 2"	27' 0"	1,654	.....	.....	.....	4 Wr. R3350 @ 3,250 h
	C-130A	Hercules	Transport	4	132' 7"	95' 2"	38' 4"	1,746	.....	108,000	124,000	4 All. T56-A-1 @ 3,750
	T2V-1	SeaStar	Trainer	2	42' 0"	38' 0"	13' 0"	.....	.....	.....	16,000	1 All. J33
	P2V-7	Neptune	Anti-sub.	..	103'	91' 5"	29' 4"	1,000	47,450	75,500	.....	2 Wr. R3350-32W @ 3,
	R7V-2	Super Constellation	Transport	4–15	117'	116' 2"	24' 6"	1,615	72,219	150,000	169,800	2 Wr. J34 @ 3,400 lb.t. 4 P&W T34-P-12A @
Glenn L. Martin Co. *Baltimore 3, Md.*	B-57B	.....	Tac. bomber	2	64'	65' 6"	16' 0"	.....	.....	.....	50,000	2 Wr. J65-W-5 @ 7,200
	P5M-2	Marlin	Anti-sub.	7	118' 0"	99'	33'	1,406	46,933	.....	73,055	2 Wr. R3350-32W @ 3,
	XP6M-1	SeaMaster	Mine-laying	5	109'	134'	31'	1,900	.....	.....	.....	4 All. J71 @ 10,000 lb.
McDonnell Aircraft Corp. *St. Louis, Mo.*	F-101A	Voodoo	Fighter	1	37' 8"	67' 5"	18' 0"	.....	.....	.....	.....	2 P&W J57-P-13 @ 10,
	F3H-2N	Demon	Fighter	1	35' 4"	58' 11"	14' 7"	.....	.....	.....	.....	1 All. J71-A-2 @ 9,500
North American Aviation, Inc. *Los Angeles, Calif.*	F-86D	Sabre	Fighter	1	37' 1"	41' 8"	15'	.....	.....	.....	18,000	1 GE J47-GE-17 @ 5,2
	F-86F	Sabre	Fighter	1	37' 1"	37' 5"	14' 7"	.....	.....	.....	17,000	1 GE J47-GE-27 @ 5,8
	F-86H	Sabre	Fighter-bomb.	1	37' 1"	38' 8"	15'	.....	.....	.....	.....	1 GE J73-GE-3
	F-86K	Sabre	Fighter	1	37' 1"	42' 4"	15'	.....	.....	18,500	20,347	1 GE J47-GE-33 @ 5,8
	F-100C	Super Sabre	Fighter	1	38'	47'	15'	.....	.....	.....	.....	1 P&W J57-P-7 @ 10,0
	F-107	.....	Fighter	..	.....	.....	.....	.....	.....	.....	.....	.....
	T-28C	.....	Trainer	2	40' 7"	34' 4"	12' 7"	.....	.....	.....	8,247	1 Wr. R1820 @ 1,425 h
	FJ-3	Fury	Fighter	1	37' 1"	37' 7"	13' 8"	.....	.....	.....	18,000	1 Wr. J65 @ 7,200 lb.t
	FJ-4	Fury	Fighter	1	39' 1"	37' 6"	12' 8"	.....	.....	.....	19,000	1 Wr. J65-W-4 @ 7,80
Northrop Aircraft, Inc. *Hawthorne, Calif.*	F-89D	Scorpion	A-W inter.	2	59' 8"	53' 9"	17' 6"	600+	.....	.....	40,000+	2 All. J35-A-35
	F-89H	Scorpion	A-W inter.	2	.....	.....	.....	.....	.....	.....	.....	.....
Republic Aviation Corp. *Farmingdale, L. I., N. Y.*	F-84F	Thunderstreak	Fighter-bomb.	1	33' 6"	43' 4"	14' 4"	.....	.....	.....	25,000	1 Wr. J65-W-3 @ 7,20
	RF-84F	Thunderflash	Recco-f't'r	1	33' 6"	47' 6"	15'	.....	.....	.....	.....	1 Wr. J65-W-3 @ 7,20
	XF-84H	.....	Research	1	33' 6"	51' 5"	15' 4"	.....	.....	.....	.....	1 All. T40-A-1 @ 5,85
	F-103	.....	Interceptor	1	.....	.....	.....	.....	.....	.....	.....	1 Wr. J67 @ 15,000 lb.
	F-105A	.....	Fighter-bomb.	1	.....	.....	.....	.....	.....	.....	.....	1 P&W J57 @ 10,000 l
Stroukoff Aircraft Corp. *West Trenton, N. J.*	XC-123D	.....	Assault trans.	2	110' 0"	76' 3"	34' 1"	1,235	.....	55,000	.....	2 P&W R2800-99W @
	YC-123E	.....	Assault trans.	2	110' 0"	77' 2"	32' 10"	1,223	34,000	55,000	.....	2 P&W R2800-99W @
Chance Vought Aircraft, Inc. *Dallas, Tex.*	F8U-1	Crusader	Day fighter	1	.....	.....	.....	.....	.....	.....	.....	1 P&W J57-P-4

POWERPLANT		PERFORMANCE					ARMAMENT	CHRONOLOGY				REMARKS
Number, manufacturer, model and max. rating	Normal fuel cap., gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Stall speed, dirty, mph.	Service ceiling, ft.	Combat radius, mi.	Number, type and designation	First flight of prototype	First production contract	First deliveries to service	First flight first prod.	
O-435-C2 @ 260 hp. -470-13 @ 225 hp.	134 50	205 189	1,230	67 54	20,000 20,000	.....	None 2 x .30-cal. mg., 6 rockets	Nov. '49 Dec. '48	.....	Jan. '52 Aug. '50	Jan. '53 Oct. '53	T-34B is Navy version
-GE @ 6,000 lb.t.	.....	600+	.....	...	40,000+	1,500+	2 x 20-mm. cannon; 20,000 lb. of bombs; GAM-63 Rascal	Dec. '47	Sept. '48	Oct. '51	June '50	Also reconnaissance version RB-47E; 34 in. longer
J57 @ 10,000 lb.t. R4360-59B @ 3,500 hp.	9,190	600+ 375	1,200	107	50,000+ 28,000	.....	None None	Apr. '52 Nov. '44	Mar. '51 July '45 Sept. '54	June '55 1947	Aug. '54 Mar. '47	Development based on 707 prototype
69 @ 900 lb.t. @ 265 hp.	.....	400 180	.....	...	.....	.....	Bombs & rockets	Sept. '54	.....	.....	.....	Improved L-19
R4360-53 @ 3,800 hp.	30,000	435+	.....	...	45,000	5,000	16 x 20-mm. cannon	Aug. '46	Aug. '47	Aug. '47	Aug. '47	Delta wing, podded engines
79-GE-1	.....	1,000	.....	...	.....	.....	GAR-98 Falcon missiles	Oct. '53	Apr. '54	Nov. '55	Oct. '55	T-29D is equivalent for bombardier-training
J57-P-23 @ 10,000 lb.t.	.....	M>1	.....	...	.....	.....	.....	Sept. '49	1952	1954	1954	Avionic test bed; 340 airframe
J57-P-23 @ 10,000 lb.t.	1,550	300	1,370	92	24,000	.....	None	Mar. '54	.....	.....	.....	Equivalent to comm. 340 Convair-Liner
R2800-99W @ 2,500 hp.	1,550	312	1,410	96	24,500	.....	None	Dec. '54	.....	1954	.....	Prototype VTO
R2800-99W @ 2,500 hp.	1,730	295	1,410	...	24,500	.....	None	May '54	.....	.....	June '54	Hydroski landing gear
R2800-99W @ 2,500 hp.	1,730	366	2,380	...	36,300	.....	None	June '54	.....	.....	.....	R3Y-1 is 142' 6" long
T56-A3 @ 3,250 hp.	1,730	314	1,230	86	.....	.....	None	Aug. '54	.....	.....	.....	
R2800-CB16 @ 2,400 hp.	.....	500+	.....	0	.....	.....	.....	Apr. '53	.....	.....	Oct. '54	
40 @ 5,850 hp.	.....	.....	.....	...	.....	.....	None	Apr. '50	.....	.....	June '55	
J46 @ 6,000 lb.t.	.....	.....	.....	...	.....	.....	.....	June '55	July '55	July '55	.....	
T40-A-10 @ 5,500 hp.	.....	350+	.....	...	.....	.....	.....	.....	.....	.....	.....	
R2800-52W @ 2,500 hp.	1,730	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	
71-A-11 @ 10,000 lb.t.	4,650	.....	.....	...	.....	.....	.....	June '54	Aug. '53	Nov. '54	Jan. '55	USAF version of original A3D design for Navy
71-A-11 @ 10,000 lb.t.	4,490	.....	.....	...	.....	.....	2 x 20-mm. cannon	June '54	May '53	.....	.....	RB-66C under development
R4360-63A @ 3,800 hp.	11,058	304	760	106	22,100	1,000	2 x 20-mm. cannon	.....	Sept. '50	Apr. '53	Feb. '53	
.....	.....	.....	.....	...	.....	.....	None	.....	.....	.....	.....	Convertible to 12 configurations; AD-6 is similar
T34-P-3 @ 5,700 eshp.	16,000	.....	.....	...	.....	.....	4 x 20-mm. cannon	Oct. '53	.....	.....	.....	
R3350 @ 2,700 hp.	.....	650	.....	...	40,000+	.....	2 x 20-mm. cannon	1954	.....	.....	.....	Smallest A-bomb carrier
J57	.....	700+	.....	...	.....	.....	.....	Jan. '51	.....	.....	.....	Holds 100 km. closed-circuit record: 728.11 mph.
J65-W-4	.....	M>1	.....	...	40,000+	.....	.....	.....	.....	.....	.....	
J57	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	
R3350-85 @ 3,500 hp.	2,624	293	800	84	30,000	1,110	None	Nov. '52	Jan. '52 Oct. '53	May '53 Oct. '54	Dec. '52 Aug. '54	Original design was Chase Aircraft's
W R2800-99W @ 2,500 hp.	1,462	220	875	75	29,000	1,460	None	.....	.....	.....	.....	
W J48-P-8 @ 7,200 lb.t.	.....	.....	.....	...	.....	.....	4 x 20-mm. cannon	Jan. '54	.....	.....	.....	Improved -6; more wing area & cambered section
J65-W-6	.....	.....	.....	...	.....	.....	Air-to-air missiles, 4 cannon	July '54	.....	.....	.....	Supersonic in level flight
R1820-82 @ 1,525 hp.	.....	.....	.....	...	.....	.....	Sonobuoys	Dec. '52	.....	.....	.....	Combines hunter-killer functions
R1820-82 @ 1,525 hp.	.....	.....	.....	...	.....	.....	None	Jan. '55	.....	.....	.....	
R1820-76A @ 1,425 hp.	1,275	275	1,400	...	.....	.....	None	.....	.....	.....	.....	Also Navy UF-1 & Coast Guard UF-1G
R1820	.....	.....	.....	...	.....	.....	None	.....	.....	.....	.....	Prototype under test
J79-GE-3	.....	M>1	.....	...	60,000	.....	.....	Feb. '54	.....	.....	Feb. '56	
J33-A-35 @ 5,200 lb.t.	813	600	4,680	100	46,000+	490	2 x .50-cal. mg.	Mar. '48	Oct. '47	Aug. '48	Sept. '48	Straightwing, very thin section
R3350 @ 3,250 hp.	7,750	376	1,640	101	27,900	.....	None	.....	.....	June '55	July '51	Also Navy TV-2, USAF RT-33
R3350 @ 3,250 hp.	7,750	300	.....	...	.....	.....	None	.....	.....	.....	.....	Equivalent of comm. versions; also Navy R7V-1
T56-A-1 @ 3,750 hp.	.....	.....	.....	...	.....	.....	.....	Aug. '54	Sept. '52	.....	Apr. '53	WV-2 is Navy equivalent
J33	.....	600	.....	...	.....	.....	6 x 20-mm. cannon	Dec. '54	.....	Apr. '54	Jan. '56	Production at Lockheed, Marietta, Ga.
R3350-32W @ 3,500 hp. +	.....	.....	.....	...	.....	.....	.....	May '45	.....	.....	.....	Navy development
J34 @ 3,400 lb.t.	.....	300	.....	...	22,000	.....	None	.....	.....	.....	.....	Holds non-stop record (11,236 mi.)
W T34-P-12A @ 5,500 hp.	8,770	450	3,360	104	38,500	.....	.....	Sept. '54	.....	.....	.....	YC-121F has P&W T34-P-6 @ 5,700 eshp.
r. J65-W-5 @ 7,200 lb.t.	.....	600+	.....	...	45,000+	.....	8 x .50-cal. mg. or 4 x 20 mm. cannon, bombs, and rockets	.....	.....	Aug. '53	.....	B-57A was test vehicle; RB-57 is recon; B-57C is transition trainer. B-57D an E are developments.
r. R3350-32W @ 3,400 hp.	2,815	250	.....	...	40,000+	.....	Mines	Aug. '53	.....	June '54	1955	Camera pod mounts in bomb bay in PR version
l. J71 @ 10,000 lb.t.	.....	600+	.....	...	.....	.....	Atomic stores, GAR-98 missiles, 4 x 20-mm. cannon; rockets	Sept. '54	Sept. '52	.....	Sept. '54 Apr. '55	Also RF-101A and F-101B 2-place
&W J57-P-13 @ 10,000 lb.t.	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	
l. J71-A-2 @ 9,500 lb.t.	.....	.....	.....	...	.....	.....	.....	Dec. '49	.....	Mar. '52	.....	
E J47-GE-17 @ 5,200 lb.t.	.....	650+	.....	...	45,000+	500	24 x 2.75-in. rockets	.....	.....	.....	Sept. '53	
E J47-GE-27 @ 5,800 lb.t.	.....	650+	.....	...	45,000+	500+	6 x .50-cal. mg., 16 x 5-in. HVAR	Apr. '53	.....	.....	.....	
E J73-GE-3	.....	630+	.....	...	45,000+	1,150	4 x 20-mm. M39 cannon	July '54	.....	.....	.....	
E J47-GE-33 @ 5,600 lb.t.	.....	650+	.....	...	45,000+	500+	4 x 20-mm. M39 cannon	May '53	Mid-1953	Sept. '54	.....	Redesignated from F-100B
&W J57-P-7 @ 10,000 lb.t.	.....	822	.....	...	50,000+	500+	20-mm. cannon	.....	.....	.....	.....	
Wr. R1820 @ 1,425 hp.	.....	.....	.....	...	.....	.....	.....	Sept. '55	Sept. '54	.....	.....	
Wr. J65 @ 7,200 lb.t.	.....	346	3,630	...	37,000	430+	.50-cal. mg.; 2.25-in. rockets	July '53	.....	.....	.....	
Wr. J65-W-4 @ 7,800 lb.t.	.....	.....	.....	...	45,000	500+	4 x 20-mm. cannon	Oct. '54	.....	.....	.....	
	.....	690+	.....	...	45,000+	.....	4 x 20-mm. cannon	.....	.....	.....	.....	
All. J35-A-35	.....	600+	.....	...	52,000+	.....	104 x 2.75-in. rockets	Oct. '51	Apr. '51	Apr. '53	Jan. '53	Armament in wingtip pods
	.....	.....	.....	...	.....	.....	104 x 2.75-in. rockets, 6 x GAR-98	.....	.....	.....	.....	
Wr. J65-W-3 @ 7,200 lb.t.	.....	650+	.....	...	45,000+	1,000	6 x .50-cal. mg.; 24 x 5" rockets	June '50	Apr. '51	Mar. '53	Nov. '52	
Wr. J65-W-3 @ 7,200 lb.t.	.....	650+	.....	...	45,000+	1,000	4 x .50-cal. mg.	Feb. '52	Apr. '51	May '54	Sept. '53	
All. T40-A-1 @ 5,850 eshp.	.....	.....	.....	...	40,000+	.....	.....	July '55	.....	.....	.....	
Wr. J67 @ 15,000 lb.t.	.....	M>1	.....	...	.....	.....	.....	Oct. '55	.....	.....	.....	Boundary-layer control tests
P&W J57 @ 10,000 lb.t.	.....	.....	.....	...	.....	.....	None	Nov. '54	Apr. '55	.....	.....	Pantobase transport
P&W R2800-99W @ 2,500 hp.	1,514	290	.....	...	.....	.....	None	July '55	Apr. '55	.....	.....	
P&W R2800-99W @ 2,500 hp.	1,514	290	.....	...	.....	.....	.....	Mar. '55	.....	.....	Sept. '55	
P&W J57-P-4	.....	1,020	.....	...	.....	.....	.....	.....	.....	.....	.....	

U.S. Gas Turbine Engines

Manufacturer	Designation	Type	No. compressor stages	No. turbine stages	No. combustors	Max. power @ S. L.	Specific fuel consumption at max. power, lb./hr./lb. or eshp.	Compression ratio at max. rpm	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
Avco Manufacturing Corp. **Lycoming Division** *Stratford, Conn.*	XT53-L-1	ACS	5+1	2	1	825 shp.	0.71	.....	23	48	460	To power Bell XH-40
Boeing Airplane Co. *Seattle, Wash.*	T50	CFP	1	2	2	210 eshp	1.3	3.0	23	40	240	Flown in Cessna XL-19B and Kaman copters.
	502-10B	CFP	1	2	2	270 eshp	1.02	4.25	23	43	245	
Continental Aviation and Engineering Corporation *Detroit, Mich.*	J69-T-9	CFJ	1	1	1	920 lb. t.	1.13	.....	....	50	364	In Cessna, Beech, Temco trainers
	J69-T-19	CFJ	1	1	1	1,000 lb. t.	1.27	.....	....	42	317	In Ryan Firebee
	T51-T-1	CFP	1	2	1	280 eshp.	0.99	.....	16	37	263	In Bell XH-13, Cessna XL-19C
	T51-T-3	CFP	1	2	1	425 eshp.	0.97	.....	....	36	236	In Sikorsky XH-39
	T51-T-5	CFP	1	2	1	392 eshp.	1.06	.....	16	47	458	Going in Sikorsky XH-39
	215	....	2	2	1	590 eshp.	.....	.....	16	48	320	Output shaft rpm: 6,000
	420	....	2	2	1	790 lb. t.	0.55	.....	....	.....	315	Airpump in Stroukoff XC-123D
Curtiss-Wright Corp. **Wright Aeronautical Division** *Wood-Ridge, N. J.*	J65-W-1, 2, 3, 5	AFJ	13	2	1	7,200 lb. t.	.....	.....	37	114	2,595	
	J65-W-4	AFJ	13	2	1	7,700 lb. t.	.....	.....	37.5	108	2,750	
	T49	AFP	....	....	....	.....	.....	.....	....	.....	.....	
	J67	AFJ	....	....	....	15,000 lb. t.	.....	.....	....	.....	.....	
Fairchild Engine and Airplane Corp. **Fairchild Engine Division** *Deer Park, L. I., N. Y.*	J44-R-20	ACJ	1	1	1	1,000 lb. t.	1.65	2.5	22	88	335	In Ryan Firebee
	FT-101E	ACJ	1	1	1	1,000 lb. t.	.....	2.5	22	96	370	For inhabited aircraft
General Electric Co. **Aircraft Gas Turbine Division** *Erendale, O.*	J47-GE-25	AFJ	12	1	8	6,970 lb. t.	.....	5.35	37	145	2,554	Powers Boeing B-47B & E, RB-47E
	J47-GE-33	AFJ	12	1	8	7,650 lb. t.	.....	5.35	37	228	3,196	Powers NAA F-86D; has afterburner
	J73-GE-3	AFJ	12	2	10	9,000 lb. t.	.....	.....	37	148	.....	Powers NAA F-86H
	J77	AFJ	....	....	....	25,000 lb. t.	.....	.....	....	.....	.....	
	J79	AFJ	....	....	....	12,000 lb. t.	.....	.....	40	.....	.....	Powers Lockheed F-104A, Convair XB-58
	....	....	....	....	....	.....	.....	.....	....	.....	.....	Nuclear power plant
	T58	....	....	....	....	1,000 eshp.	.....	.....	....	.....	.....	High T/W ratio
	X84	....	....	....	....	.....	.....	.....	....	.....	.....	Turbofan dev. by company.
	Nuclear eng.	....	....	....	....	.....	.....	.....	....	.....	.....	
General Motors Corp. **Allison Division** *Indianapolis, Ind.*	J33-A-18A	CFJ	1	1	14	4,600 lb. t.	1.14	4.35	49	94	1,790	In C-V Regulus
	J33-A-35	CFJ	1	1	14	4,600 lb. t.	1.14	4.35	52	106	1,820	In Lockheed T-33A, TV-2
	J33-A-37	CFJ	1	1	14	4,600 lb. t.	1.14	4.35	52	156	1,520	In Martin TM-61A Matador
	J71-A-2	AFJ	16	3	....	10,000 lb. t.	.....	.....	43	285	4,017	In McDonnell F3H-2N Demon
	J71-A-11	AFJ	16	3	....	10,000 lb. t.	.....	.....	48	101	3,829	In Douglas RB-66, B-66
	T56-A-1	AFP	14	4	6	3,750 eshp.	0.54	9.25	40	145	1,645	In Lockheed C-130 Hercules
	501-D13	AFP	14	4	6	3,750 eshp.	0.54	9.25	36	145	1,750	To power Lockheed Electra
	501-D15	AFP	....	....	....	4,050 eshp.	.....	.....	....	.....	.....	
	550	AFP	....	....	....	5,500 eshp.	.....	.....	....	.....	.....	Split-compressor
United Aircraft Corp. **Pratt & Whitney Aircraft Division** *E. Hartford, Conn.*	J48	CFJ	1	1	....	7,200 lb. t.	.....	.....	....	.....	.....	
	J57	AFJ	....	....	....	10,000 lb. t.	.....	.....	....	.....	.....	
	J75	AFJ	....	....	....	15,000 lb. t.	.....	.....	....	.....	.....	
	T34	AFP	13	3	8	5,700 eshp.	.....	6.7	34	158	2,564	
	T57	....	....	....	....	15,000 eshp.	.....	.....	....	.....	.....	
	PT2G-3	AFP	....	....	....	6,000 eshp.	0.63	.....	34	157	2,650	
	JT3C-4	AFJ	....	....	....	11,000 lb. t.	.....	.....	....	.....	.....	Commercial J57
	JT4A-3	AFJ	....	....	....	15,000 lb. t.	.....	.....	....	.....	.....	Commercial J75
	Nuclear eng.	....	....	....	....	.....	.....	.....	....	.....	.....	
Westinghouse Electric Corp. **Aviation Gas Turbine Division** *Kansas City, Mo.*	J34-WE-34	AFJ	11	3	1	3,250 lb. t.	1.06	4.1	24	120	1,233	
	J46	AFJ	....	....	....	4,000 lb. t.	.....	.....	....	.....	.....	
	XJ54	....	16	....	....	6,500 lb. t.	.....	.....	....	.....	.....	
	XJ81	....	....	....	....	.....	.....	.....	....	.....	.....	

Abbreviations:
ACJ—Axial-centrifugal turbojet
ACS—Axial-centrifugal shaft turbine
AFJ—Axial-flow turbojet
AFP—Axial-flow turbojet
CFJ—Centrifugal-flow turbojet
eshp—Equiv. shaft horsepower
lb. t.—Pounds thrust

USSR Military Aircraft

Basic Data				Physical Data			Powerplant	Performance		Armament	Remarks
	Designation	NATO Code name	No. of crew	Overall span, ft.	Overall length, ft.	Gross weight, lb.	Powerplant (No., designation and power, each eng.	Maximum speed, mph.	Service ceiling, ft.		
FIRST-LINE AIRCRAFT											
STRATEGIC BOMBERS	Il-38	Bison	...	170	140	250,000	4 x M209 tj @ 15,000 lb.t.	610	.....	.....	Comparable to B-52; 70 in service
	Tu-?	Bear	...	170	150	.....	4 x M022 tp @ 4,500 hp.	400	.....	.....	Intercontinental range
	Il-?	Badger	...	100	105	150,000	2 x M209 tj @ 15,000 lb.t.	600	50,000	.....	Comparable to Boeing B-47
TACTICAL BOMBERS	Il-28	Beagle	3	68	62	.....	2 x RD45 tj @ 5,000 lb.t.	600	45,000	2 x 23-mm. 2 x 12.7-mm.	Satellite production and use
	Tu-?	Bosun	3	70	65	50,000	2 x VK1 tj @ 5,000 lb.t.	500	.....	.....	Torpedo bomber
FIGHTERS	La-14	Flashlight	2	...	...	30,000	2 x axial tj @ 10,000 lb.t.	600	.....	.....	Also as light bomber
	Yak-?	Farmer	1	...	...	.....	1 x axial tj @ 10,000 lb.t.	M>1	.....	.....	Low-set slab tail; 3,000 in service
	MiG-17	Fresco	1	33	37	15,000	1 x VK2JA tj @ 6,850 lb.t.	M>1	51,000	2 x 23-mm. 1 x 37-mm.	MiG-15 development
	MiG-15	Fagot	1	33	36	11,268	1 x VK2 tj @ 5,950 lb.t.	683	51,000	2 x 23-mm. 1 x 37-mm.	Satellite production and use; 15,000 minimum built
	Yak-9P	Frank	1	31	28	6,985	1 x VK107A @ 1,600 hp.	370	.....	1 x 20-mm. 2 x 12.7-mm.	Satellite use
HELICOPTERS	Mi-2	Hare	1	48[1]	....	5,400	1 x ASh21 @ 640 hp.	....	.....	None	Folding, wood-fabric blades
	LAR-3	Hound	2	60[1]	...	12,015	1 x ASh62IR @ 1,000 hp.	130	11,800	None	Used at North Pole stations
	Mi-4	Horse	2	60[1]	75	22,000	2 x ASh62IR @ 1,000 hp.	.....	.....	None	Uses two LAR-3 rotor systems
TRANSPORTS	An-2	Colt	2	54	35	11,000	1 x ASh62IR @ 1,000 hp.	137	27,890	None	Holds FAI altitude record
	Il-12	Coach	2-5	104	70	38,000	2 x ASh82FNV @ 1,850 hp.	252	.....	None	Used by Polish, Czech & USSR airlines; 3,000 built.
	Il-14	Crate	2-5	104	70	40,000	2 x ASh82J @ 2,600 hp.	...	.....	None	Il-12 development/replacement
SUPPORT AIRCRAFT											
BOMBERS	Il-10	Beast	2	45.5	40.0	.....	1 x AM42 @ 2,000 hp.	300	.....	2 x 7.62-mm. 1 x 12.7-mm.	Satellite use
	Il-28	Butcher	3	68	62	.....	2 x axial @ 5,000 lb.t.	570	45,000	2 x 23-mm. 1 x 20-mm.	Production predecessor of IL-28
	Tu-4	Bull	6-8	141	99	.....	4 x ASh 82 FNV @ 1,850 hp.	225	.....	.....	Russian copy of Boeing B-29
	Tu-?	Barge	...	185	145	210,000	4 x tp @ 4,500 hp.	380	.....	.....	Pre-production quantities; was turboprop testbed for Bear
	Tu-2	Bat	5	61.9	45.3	28,224	2 x ASh82FNV @ 1,850 hp.	360	36,000	2 x 20-mm. 2 x 12.7-mm.	Polish and Red Chinese service
FIGHTERS	La-7	Fin	1	32.3	28.5	7,482	1 x ASh82FNV @ 1,850 hp.	373	.....	.....	Second-line Red Chinese fighter
	La-9	Fritz	1	31.4	29.4	8,230	1 x ASh82FNV @ 1,850 hp.	394	.....	1 x 20-mm. 2 x 12.7-mm.	Russian trainer, Chinese fighter
	La-11	Fang	1	32.5	28.4	7,700	1 x ASh82FNV @ 1,850 hp.	420	.....	3 x 20-mm.	Last Russian piston-eng. fighter
	La-?	Fantail	1	37	40	.....	1 x RD45F @ 5,500 lb.t.	640	.....	2 x 23-mm.	Type 21; was called LA-17
	MiG-9	Fargo	1	34	33	14,000	2 x M004 @ 2,200 lb.t.	595	.....	1 x 23-mm. 2 x 20-mm.	First Red twin-jet; now trainer
	Yak-17	Feather	1	30	28	.....	1 x M004 @ 2,200 lb.t.	505	.....	2 x 20-mm.	Yak-15 development
	Yak-23	Flora	1	30	29	.....	1 x RD500 @ 3,500 lb.t.	610	45,000	.....	Polish, Bulgarian service
	Yak-3	.....	1	31	29	4,848	1 x VK105PF @ 1,210 hp.	343	.....	1 x 20-mm. 2 x 12.7-mm.	Satellite use
TRANSPORTS	Li-2	Cab	2	95	64	.....	2 x M62R @ 1,000 hp.	.....	.....	None	Russian-built Douglas C-47
	Tu-70	Cart	4	141	119	.....	4 x Ash 82 FNV @ 1,850 hp.	215	.....	None	Development of Tu-4 (Boeing B-29)
	Pe-8	.....	...	131	81	70,500	4 x M82III @ 1,700 hp.	240	23,000	None	Was bomber; now special duties
	Shche-2	.....	2	72	50	.....	2 x M11D @ 145 hp.	110	.....	None	Was Aeroflot feeder; now Polish
	Yak-16	Cork	2	66	49	14,000	2 x ASh21 @ 750 hp.	190	16,000	None	In service with Aeroflot
	Il-20	.....	3	68	62	.....	2 x RD45F @ 5,000 lb.t.	600	45,000	None	Il-28 "jet transport" conversion
TRAINERS	U-Il-28	Mascot	3	68	62	.....	2 x RD45F @ 5,000 lb.t.	600	45,000	.....	Il-28 development; satellite use
	U-MiG-15	Midget	2	33	36	12,000	1 x VK2 @ 5,950 lb.t.	650	51,000	.....	Satellite use
	Pe-2	Buck	3	56	41	18,730	2 x VK105R @ 1,100 lb.t.	340	29,000	4 x 7.62-mm. 2 x 12.7-mm.	Satellite use
	Yak-11	Moose	2	31	28	4,900	1 x ASh21 @ 750 hp.	295	.....	.....	Holds FAI closed-circuit records
	U-Yak-17	Magnet	2	30	28	.....	1 x M004 @ 2,200 lb.t.	505	.....	2 x 20-mm.	Conversion trainer
	Yak-18	Max	2	35	26	2,360	1 x M11RF1 @ 160 hp.	160	16,400	None	Holds FAI speed records
	UT-2	Mink	2	34	23	2,075	1 x M11G @ 110 hp.	122	2,075	None	Satellite use; basic trainer
	Yak-12	Creek	4	39	28	2,650	1 x M11 @ 145 hp.	115	13,200	None	Air ambulance/communications
MISCELLANEOUS	Ka-10	.....	1	...	...	.....	1 x Pobieda @ 50 hp.	.....	.....	None	Ultra-light co-axial 'copter
	Po-2	Mule	2	37	27	1,910	1 x M11 @ 110 hp.	96	13,200	None	Satellite use; freighter/agric.
	GST	Mop	3-4	104	63	27,000	2 x M62R @ 1,000 hp.	190	25,000	.....	Russian-built Consol. PBY
	MDR-6	Mug	3	66	49	.....	2 x M62R @ 1,000 hp.	160	.....	.....	Flying boat

[1] Rotor diameter

Abbreviations:
AM—A. A. Mikulin
An—O. K. Antonov
ASh—A. D. Shvetsov
G—Mikhail Gurevich
Il—Sergei Ilyushin
La—Semyon Lavochkin
M—Motor (Old designation)
Mi—Artem Mikoyan
Mil—Mikhail Mil
Po—Vladimir Petlyakov
Po—Nikolai Polikarpov
Shche—S. O. Shcherbakov
Tu—Andrei Tupolev
UT—Uchebnii Trenirovochnii (trainer)
VK—V. Klimov
Yak—Aleksandr Yakovlev

Other NATO code names given to Russian types include: Fred, Bob and Bank (Bell P-63A, Douglas A-20 and North American B-25 respectively, sent to USSR during WW 2; Bob (Il-4, Bark (Il-2); Clam (Il-18 four-engine transport); Crib (Yak-6); Crow (Yak-14); Mark (Yak-7); Moto (MBR-2); Madge (seaplane similar to Martin Mariner); and the undisclosed Mole, Mare and Mist.

Now—

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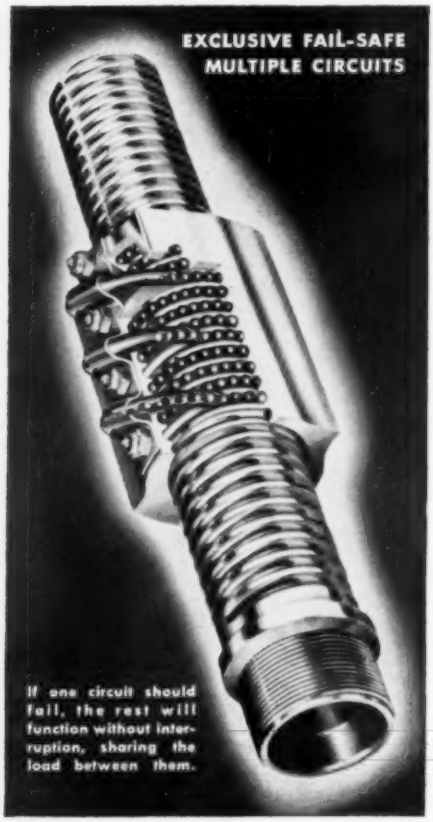
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If one circuit should fail, the rest will function without interruption, sharing the load between them.

SPACE/WEIGHT SAVINGS PERMIT MORE PAYLOAD

Compared to either Acme screw or hydraulic actuators, *Saginaw b/b Screws* save significant weight and space by permitting the use of smaller motors and gear boxes; eliminating pumps, piping, etc.

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Saginaw ball bearing Screw

U.S. Commercial Transports

Manufacturer	Model	Name	No. of crew	No. of passengers	Cargo capacity, lb.	Number, designation of powerplants [3]	Maximum speed, mph.	Best cruise speed, mph.	Landing speed, flaps and landing gear down, mph.	Engine-out en route climb, fpm.	CAA field length (takeoff), ft.	CAA field length (landing), ft.	Maximum still-air range, mi.	Weight empty, lb.	Maximum gross weight, lb.	Maximum landing weight, l	Wingspan, ft.	Overall length, ft.	Maximum height, ft.
Boeing Airplane Co.	707–120	Jet Stratoliner	3	80–130	.....	4 P&W JT3-P	...	600	...	...	.....	.....	.....	.....	230,000+	165,000	130' 10"	134' 6"	38' 3"
	707–220	Jet Stratoliner	3	80–130	.....	4 P&W JT-4	...	600	...	...	.....	.....	.....	.....	245,000+	175,000	130' 10"	134' 6"	38' 3"
	707–320	Intercontinental	4	124–146	.....	4 P&W JT-4	...	600	...	...	.....	.....	4,000+	.....	280,000+	190,000	141' 6"	146' 8"	38' 11"
Convair Division General Dynamics Corp.	340	Convair-Liner	3	44	5,400	2 P&W R2800-CB-16	314	284	86	1,220	4,675	.....	1,260	29,486	47,000	46,500	105' 4"	79' 2"	28' 2"
	440	Metropolitan	4	44–52	5,400	2 P&W R2800-CB-17	310	289	85	150	5,000	4,010	2,752	31,305	49,100	47,650	105' 4"	79' 2"	28' 2"
	22	.....	5	80–99	.....	4 GE J79	...	580	...	...	.....	.....	.....	72,500	170,000	.....	118'	118'	35'
Douglas Aircraft Co., Inc.	DC-6A	Liftmaster	3–5	0	30,500	4 P&W R2800-CB-17	370	315	97	493	6,100	5,160	5,000	51,316	107,000	88,200	117' 6"	100' 6"	28' 8"
	DC-6B	(domestic version)	5	54	16,780	4 P&W R2800-CB-16	370	315	95	460	5,680	4,995	3,720	55,357	100,000	85,000	117' 6"	106' 6"	28' 8"
	DC-6B	(overwater version)	7 [2]	89	11,930	4 P&W R2800-CB-17	370	315	97	493	6,100	5,160	5,000	58,340	107,000	88,200	117' 6"	106' 6"	28' 8"
	DC-7	(domestic version)	3	69–99	12,310	4 Wr 972TC18DA2	410	370	...	448	3,490	5,765	4,430	64,480	122,200	97,000	117' 6"	108' 11"	28' 7"
	DC-7B	(overwater version)	3	69–99	17,730	4 Wr 972TC18DA4	412	361	...	525	3,780	5,870	5,120	68,073	126,000	102,000	117' 6"	108' 11"	28' 7"
	DC-7C	Seven Seas	5	62–99	18,100	4 Wr 988TC18EA1	406	359	...	507	5,700	5,400	6,010	72,643	140,000	109,000	127' 6"	112' 3"	31' 10"
	DC-8	(domestic)	...	122–144	14,150	4 P&W JT-3c-4	...	561	.....	.....	9,440	6,680	3,550	119,726	265,000	189,000	139' 9"	148' 10"	42' 4"
	DC-8	(domestic)	...	122–144	14,150	4 P&W JT-4A-3	...	586	.....	.....	8,640	6,630	4,030	123,532	265,000	189,000	139' 9"	148' 10"	42' 4"
	DC-8	(intercontinental)	...	132–144	14,150	4 P&W JT-4A-3	...	586	.....	.....	8,760	6,690	4,470	128,862	287,500	190,500	139' 9"	148' 10"	42' 4"
	DC-8	(intercontinental)	...	132–144	14,150	4 Rolls Royce Conway	...	582	...	.....	9,000	6,690	4,810	123,726	287,500	190,500	139' 9"	148' 10"	42' 4"
Lockheed Aircraft Corp.	1049G	Super Constellation	5–11	47–99	.....	4 Wr 972TC18DA3	370	335	101	630	6,300	5,250	5,580	73,016	137,500	113,000	123' 5"	116' 2"	24' 9"
	1049H	Super Constellation	5–11	.....	40,000	4 Wr 972TC18DA3	370	335	101	630	6,300	5,250	5,580	70,000	137,500	113,000	123' 5"	116' 2"	24' 9"
	1649A	Super Constellation	5–11	47–99	.....	4 Wr 988TC18EA2	377	350	101	550	6,520	6,050	6,400	85,553	156,000	123,000	150'	116' 2"	24' 9"
	188	Electra	3–6	66–91	.....	4 All 501–D13	450	410	....	.....	.....	.....	3,000	.....	110,000	93,400	99'	104' 2"	32' 3"

Abbreviations:
P&W — Pratt & Whitney Aircraft.
Wr — Wright Aeronautical Division.
All — Allison Division, GMC.
lb.t. — Pounds of thrust.
hp. — Horsepower.

Footnotes:
[1] Figure is sea level rate of climb.
[2] Includes two cabin attendants.
[3] For power Ratings, see other engine specification tables.

Lighter-Than-Air Craft

Manufacturer	Model	Name	Primary mission	No. of crew	No. of passengers	Envelope diameter, ft.	Overall length, ft.	Overall height, ft.	Number, description and maximum rating of powerplants
Goodyear Aircraft Corporation	ZSG-4	.....	ASW	8	...	62.10	266.48	81.48	2 P&W R1340 @ 600 hp.
	ZS2G	.....	ASW	8	...	67.52	285.14	89.70	2 Wr R1300-4 @ 700 hp.
	ZPG-2	.....	ASW	14	...	75.42	342.65	94.68	2 Wr R1300-4 @ 700 hp.
	ZPG-2W	.....	AEW	21	...	75.42	342.65	105.24	2 Wr R1300-4 @ 700 hp.
	TZ123,000 ("L")	Enterprise Type	Advertising and Fabric Research	1	6	39.6	148.1	54.5	2 Warner Scarab @ 145 hp.

Abbreviations:
AEW—Airborne Early Warning
ASW—Anti-Submarine Warfare
P&W—Pratt & Whitney Aircraft
Wr—Wright Aeronautical Division

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U.S. Civil and Military Rotary-Wing Aircraft

General Data						Dimensions			Weights			Powerplant		Performance			Remarks
Manufacturer	Model No.	Military designation	Number of crew	No. of passengers	Cargo cap., lb.	Rotor dia., ft.	Max. length (dbls. unfolded), ft.	Overall height to top of rotor, ft.	Weight empty, lb.	Normal gross wt., lb.	Max. gross wt., lb.	Manufacturer and designation	Max. rating, hp. or ehp. per engine	Max. speed, mph. at altitude, ft.	Hovering ceiling in ground effect, ft.	Normal still-air range, mi.	
Bell Aircraft Corp.	201	XH-13F	1	2	180	35' 1"	41' 5"	9' 5"	1,504	2,150	2,500	1 Con. Artouste I	200	95 S.L.	10,100	89	Derated engine
	47G	H-13G	1	2	465	35' 1"	41' 5"	9' 5"	1,435	2,350	2,350	1 AM 6V4-200-C32	200	99 S.L.	8,600	247	
	47G-2	H-13H	1	2	330	35' 1"	41' 5"	9' 5"	1,564	2,350	2,350	1 Lyc. VO-435	200	95 S.L.	15,700	251	Derated engine
	47H		1	2	446	35' 1"	41' 4"	9' 3"	1,502	2,350	2,350	1 AM 6V4-200-C32	200	102 S.L.	9,900	219	
	47J	HUL-1	1	3	650	37' 2"	43' 4"	9' 4"	1,510	2,550	2,550	1 Lyc. VO-435	200	108 S.L.	15,900	194	Derated engine
	61	HSL-1	4			51' 6"	70' 0"	14' 6"				1 P&W R2800-50	1,900	132 S.L.			Twin-tandem rotors, derated engine
	200	XV-3	1			25' 0"	30' 0"	13' 6"				1 P&W R985		160 2500			Convertiplane, twin rotors on wingtips
	204	XH-40	1	5	800	44' 0"	57' 0"	11' 1"	3,344	5,194	5,619	1 Lyc. XT-53	700	152	19,000	202	Derated engine
Bensen Aircraft Corp.	B-4		1	(1)	50	29' 0"	29' 0"	8' 0"	340	720		1 BPI H-59	40	62 S.L.		100	
	B-6		1		100	20' 0"	20' 0"	5' 4"	103	278	378	None					
	B-7		1		125	20' 0"	20' 0"	5' 10"	95	270	395	None					
	B-7W		1		90	20' 0"	20' 0"	7' 8"	130	305	400	None					
	B-7M		1		30	20' 0"	20' 0"	5' 10"	180	385	450	1 BPI H-59	40	71 S.L.		120	
Brantly Helicopter Corp.	B2		1	1	350	23' 8"	34' 3"	6' 10"	930	1,500	1,500	1 Lyc. 340A1A	170	110 S.L.		250+	
Cessna Aircraft Co.	CH-1		1	1	400	35' 0"	42' 6"	8' 6"	2,045	3,000	3,000	1 Con. FSO-470	260	122 S.L.	13,200	290	
Convertawings, Inc.	A		1	0		19' 5"	35' 0"	10' 0"		2,200		2 Con. C-90-12F	90				Four-rotor convertiplane
Doman Helicopters, Inc.	LZ-5	YH-31	1	7	1,400	48' 0"	58' 9"	10' 5"	3,250	5,200	5,200	1 Lyc. SO-580-A1A	400	99 1,000	4,000	210	
Flettner Aircraft Corp.	201		2		6,000	77' 5"	85' 0"	30' 0"	22,454	33,000		2 All. 501C-4	3,450	191 S.L.	15,200		Design study
Glenview Metal Products Co.	R, S		1	1		32' 0"	35' 7"	7' 8"	1,150	1,655		1 Lyc. O-290-D2	140	118 2,000	4,200	220	
E. Gluhareff Helicopters	EGHX-5		1						64	274		1 pressure jet					
Gyrodyne Co. of Amer., Inc.		XRON-1	1	0								1 BPI					
Hiller Helicopters	12-C	H-23C	1-2	1-2	440	35' 0"	40' 6"	9' 9"	1,642	2,500	2,500	1 AM 6V4-200-C33	200	84 S.L.	2,600	138	
	HJ-1	H-32	1	1	300	23' 8"	23' 8"	7' 10"	544	1,080	1,080	1 Hiller 8RJ2B	40				HOE-1 also
Jacobs Aircraft Engine Co.	104		1	4	680	36' 0"	32' 11"	10' 10"	2,350	3,475	3,475	1 Jacobs R755EH	350	175 S.L.		300	Convertiplane
Kaman Aircraft Corp.	K-240	HTK-1	2	1		41' 0"	41' 0"	12' 3"	2,300	3,000	3,000	1 Lyc. O-435-K1	250	86 S.L.	4,500	120	
	K-10		2			41' 0"	41' 0"	12' 3"		3,000	3,000	2 Boeing 502-2	190				Development project only
	K-5		2			38' 0"	38' 0"	11' 6"		2,500	2,500	1 Boeing 502-2	190				Development project only
	K-600	HOK-1	2	2	1,000	47' 0"	47' 0"	12' 8"	4,290	5,482	5,934	1 P&W R1340-48	600	115 8,000	13,700	290	
Kellett Aircraft Corp.	KH-15		1	0								2 RMI rockets	16				Research vehicle
	KH-17A		1	0								1 Jac. R755 B and 2 Lyc. O290-D2					Flying test bed
McDonnell Aircraft Corp.	82	XV-1	1	3		26' 0"	30' 0"	10' 0"				1 Con. R975-19 3 pressure jets	550				Convertiplane
Nagler Helicopter Co., Inc.	160		1	0		20' 0"				750		1 McC 431S	70	90 S.L.			Test vehicle
	161		1	1		20' 0"				1,200		1 McC 631S	115	120 S.L.			Designed
Piasecki Helicopter Corp.	PD-18	HUP-2	1	5-6	1,500	35' 0"	56' 11"	13' 2"	4,100	5,750	6,100	1 Con. R975-46	550	108 S.L.	7,000	490	
	PD-18	H-25A	1	5-6	1,500	35' 0"	56' 11"	12' 6"	3,928	5,750	6,100	1 Con. R975-46	550	108 S.L.	7,000	490	Navy equivalent is HUP-3
		HUP-4	1									1 Wr. R1300-3	700				
	PD-22	H-21A	1-2	14		44' 0"	86' 4"	16' 0"	8,300	11,200	14,500	1 Wr. R1820-103	1,150	140 S.L.	14,900	450	Power limited by transmission
	PH-42	H-21B	1-2	20		44' 0"	86' 4"	16' 0"	8,600	13,300	15,000	1 Wr. R1820-103	1,425	140 S.L.	6,000	400	
	PH-42	H-21C	1-2	20	4,500	44' 0"	86' 4"	16' 0"	8,600	13,300	15,000	1 Wr. R1820-103	1,425	140 S.L.	6,100	400	
		YH-16	2-3	40		82' 0"	134' 0"	31' 0"		30,000		2 P&W R2180	1,650				YH-16A has Allison T38s
Rotor Craft Corp.			1	0								Rocket					
Sikorsky Aircraft Div.	S-55	H-19A	1-2	10	1,800	53' 0"	62' 7"	13' 4"	4,795	7,200	7,200	1 P&W R1340	600	101 S.L.	2,200	405	Also H-19C, HO4S-1, HRS-1 & -2
		H-19B	1-2	10	2,200	53' 0"	62' 7"	13' 4"	5,045	7,500	7,900	1 Wr. R1300-3	700	110 S.L.	8,500	395	Also H-19D, HO4S-2, HO4S-3, HRS-3
	S-56	HR2S-1	2			72' 0"	82' 10"	17' 1"			28,500	2 P&W R2800-50	1,900				Also Army H-37A
	S-58	HSS-1	2-4			56' 0"	65' 10"	14' 4"				1 Wr. R1820-84	1,525	134 S.L.	10,000	384	Also Army H-34A
	S-59	XH-39	1-2	2-3	800	35' 0"	41' 7"	9' 8"	2,200	3,625	3,625	1 Con. Artouste II	425	146 S.L.	8,500	288	Holds speed (156 mph) and altitude records (24,500 ft.)
Transcendental Aircraft Corp.	1-G		1			17' 0"						1 Lyc. GO-290	160				Convertiplane test vehicle

Engine abbreviations:
AM—Aircooled Motors
BPI—Barmotive Products Inc.
Con.—Continental Motors Corp.
Jac.—Jacobs Aircraft Engine Co.
Lyc.—Lycoming Division
McC—McCulloch Motors
P&W—Pratt & Whitney Aircraft
RMI—Reaction Motors, Inc.
Wr.—Wright Aeronautical Division

Footnote: 1—lb. thrust

U.S. Personal and Business Aircraft

Manufacturer and address	Designation	No. of seats	Overall span, ft.	Overall length, ft.	Max. height, 3-pt., ft.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross wt., lb.	Number, make, model and max. rating	Normal fuel cap., gal.	Max. speed, mph.	Landing speed, mph.	CAA field length (takeoff), ft.	CAA field length (landing), ft.	Max. range, mi.	Price, FAF, $	Remarks
Aerocar, Inc. *Longview, Wash.*	Flying Auto.	2	34′	21′	7′ 6″	190	1,400	1,950	1 Lyc. O320 @ 143 hp.	24	110+	50	1,000	400	300	25,000	
Aero Design & Eng'g. Co. *Bethany, Okla.*	560A/L-26B	7	44′	35′ 5″	14′ 9″	242	4,145	6,000	2 Lyc. GO 480-D1A @ 275 hp.	156	206	68	1,100	1,050	1,050	74,500	
	(HC) 560 A	7	44′	35′ 5″	14′ 9″	242	.....	6,000	2 Lyc. GO 480-C1B6 @ 295 hp.	156	216	68	.....	.....	1,080	76,500	
	680 Super/L-26C	7	44′	35′ 5″	14′ 9″	242	4,330	7,000	2 Lyc. GSO 480-A1A-6 @ 340 hp.	223	260	71	1,575	1,630	1,600	84,500	
Aero-Flight Aircraft Corp. *Long Beach, Calif.*	Streak-165	2	25′ 3″	22′ 4″	8′ 3″	.....	.....	1,695	1 AM @ 165 hp.	40	219	57	429	480	1,060	.....	
Baumann Aircraft Corp. *No. Hollywood, Calif.*	Brigadier B-290	5	41′	29′	11′	209	2,750	4,050	2 Con. C145-2HP @ 145 hp.	78	190	57	850	500	750	44,500	
Bee Aviation Associates, Inc. *San Diego, Calif.*	Wee Bee	1	18′ 0″	14′ 2″	5′ 0″	44	210	410	1 Kiek. O45-35 @ 30 hp.	2.5	82	45	500	500	50	.....	Prone pilot
	Honey Bee	1	28′ 0″	16′ 10″	7′ 8″	96	610	860	1 Con. A65 @ 65 hp.	8 8	120	45	700	500	240	.....	
	Queen Bee	4	32′ 10″	22′ 1″	8′ 6″	130	1,190	2,150	1 Lyc. O320 @ 150 hp.	36	175	55	700	700	600	10,000	
Beech Aircraft Corp. *Wichita 1, Kan.*	Super 18 (E18S)	9	49′ 8″	35′ 2″	9′ 6″	361	6,050	9,300	2 P&W R985-AN14B @ 450 hp.	286	234	.....	.....	.....	.....	98,975	
	Bonanza G35	4	32′ 10″	25′ 2″	6′ 6″	178	1,722	2,775	1 Con. E 225 @ 225 hp.	39	194	55	.....	.....	.....	21,990	
	Twin Bonanza D50	6	45′ 3″	31′ 6″	11′ 4″	277	3,981	6,300	2 Lyc. GO 480 @ 295 hp.	134	214	71	.....	.....	.....	77,000	
	Twin Bonanza C50	6	45′ 3″	31′ 6″	11′ 4″	277	3,956	6,000	2 Lyc. GO 480-F6 @ 275 hp.	134	.....	69	.....	.....	.....	75,000	Mil. version is L-23B
	Model 73	2	32′ 9″	30′ 2″	9′ 11″	178	2,925	4,521	1 Con. J69-T-9 @ 920 lb.t.	180	295	69	.....	.....	.....	.....	
Call Air *Afton, Wy.*	A-4 (150)	2	35′ 10″	23′ 5″	7′ 0″	182	975	1,550	1 Lyc. O320-A2A @ 150 hp.	25	120	45	400	400	520	6,995	
	A-4 (Ag.)	1	33′ 1″	23′ 5″	7′ 0″	180	975	2,150	1 Lyc. O320-A2A @ 150 hp.	25	110	43	750	400	400	6,395	
	Super Cadet	2	35′ 1″	23′	7′ 3″	76	1,050	1,650	1 Lyc. O320-A2A @ 150 hp.	40	125	38	400	400	546	6,250	
Camair *Galveston, Tex.*	Model 480	4	34′ 8″	28′ 0″	10′ 8″	184	2,950	4,323	2 Con. O470-B @ 240 hp.	109	205	62	.....	.....	900	41,500	
Cessna Aircraft Co. *Wichita, Kan.*	170	4	36′ 0″	25′ 0″	6′ 7″	175	1,245	2,200	1 Con. O300-A @ 145 hp.	42	140+	.....	.....	.....	.....	8,295	
	180	4	36′ 0″	26′ 0″	7′ 6″	175	1,490	2,550	1 Con. O470-K @ 225 hp.	60	165+	.....	.....	.....	.....	12,950	182 has tri. gear
	310	5	36′ 0″	27′ 0″	10′ 5″	175	2,850	4,600	2 Con. O470-B @ 240 hp.	100	220+	.....	.....	.....	1,000	54,950	
	172	4	36′ 0″	25′ 0″	8′ 6″	175	1,260	2,200	1 Con. O300-A @ 145 hp.	42	135+	.....	.....	.....	.....	8,750	Tricycle gear
Champion Aircraft *St. Paul, Minn.*	Champion	2	35′ 2″	22′ 6″	6′ 10″	170	800	1,450	1 Con. C90-12 @ 90 hp.	28	115	44	.....	.....	.....	.....	Available in 3 mods.
Colonial Aircraft Corp. *Deer Park, L. I., N. Y.*	Skimmer	3	34′ 0″	23′ 6″	8′ 10″	151	1,450	2,150	1 Lyc. O320 @ 150 hp.	30	127	50	725	600	700	15,750	Amphibian
Custer Channel Wing Corp. *Hagerstown, Md.*	CCW-5	6	41′ 2″	28′ 8″	10′ 10″	.....	2,900	5,400	2 Con. S0-470B	.....	300	15	.....	.....	.....	65,000	Price is estimate
Fletcher Aviation *Rosemead, Calif.*	Defender	1	30′ 0″	21′ 11″	6′ 3″	150	1,160	1,917	1 Con. E225 @ 250 hp.	60	187	48	.....	.....	.....	.....	
	Utility	5	42′ 0″	31′ 10″	9′ 4″	294	1,870	3,500	1 Con. O470-E @ 225 hp.	44	.....	48	870	.....	410	24,920	
Florida Flight Eng'g. Corp. *Miami 48, Fla.*	Mid-Jet BT-1	2	18′ 4″	18′ 6″	.....	66	505	1,050	1 Tur. Palas @ 340 lb.t.	50	350	68	3,200	2,500	.....	.....	
Hayden Aircraft Corp. *Bellflower, Calif.*	Stout Bushmaster	21	74′ 6″	50′ 4″	13′ 9″	843	6,500	12,500	3 P&W R985 @ 450 hp.	.....	145	55	.....	.....	500	100,000	
Helio Aircraft Corp. *Norwood, Mass.*	Courier	4	39′ 0″	30′ 0″	8′ 10″	231	1,920	2,800	1 Lyc. GO435-C2B @ 260 hp.	61	157	30	495	495	600	24,500	
Lamson Aircraft Co. *Seattle, Wash.*	Air-Tractor	1	33′ 7″	29′ 8″	11′ 3″	350	.....	5,500	1 P&W R985 @ 450 hp.	75	.....	55	1,200	.....	.....	23,000	Spray/duster
Monocoupe Aircraft of Fla., Inc. *Melbourne, Fla.*	Meteor Mk. 2	4	32′	25′	6′ 1″	160	1,750	3,100	2 Lyc. O320 @ 150 hp.	90	193	58	.....	.....	800	25,000	
Mooney Aircraft, Inc. *Kerrville, Tex.*	Mite	1	26′ 11″	17′ 8″	6′ 3″	95	560	850	1 Con. A65-8 @ 65 hp.	15	142	45	.....	.....	420	3,695	
	Mark 20	4	35′ 0″	23′ 2″	8′ 5″	167	1,400	2,450	1 Lyc. O320 @ 150 hp.	50	177	57	.....	.....	1,000	12,500	
Piper Aircraft Corp. *Lock Haven, Pa.*	Super Cub	2	35′ 4″	22′ 6″	6′ 8″	179	930	1,750	1 Lyc. O320 @ 150 hp.	36	130	43	200	350	460	5,995	
	PA-18A	1	35′ 4″	22′ 6″	6′ 8″	179	1,060	2,070	1 Lyc. O320 @ 150 hp.	36	105	45	300	410	360	6,145	Agricultural duties
	Tri-Pacer	4	29′ 4″	20′ 7″	8′ 4″	148	1,100	2,000	1 Lyc. O320 @ 150 hp.	36	139	49	725	600	560	7,295	
	Apache	4	37′ 0″	27′ 1″	9′ 6″	204	2,180	3,500	2 Lyc. O320 @ 150 hp.	72	180	52	900	670	800	34,000	5-seater optional
	PA-18 (95)	2	35′ 4″	22′ 4″	6′ 8″	179	800	1,500	1 Con. C90 @ 95 hp.	18	112	42	390	385	366	4,795	
Royal Aircraft Corp. *Milwaukee 14, Wis.*	Royal Gull	5	44′ 4″	35′ 6″	13′ 0″	270	4,400	6,000	2 Lyc. GO480-B1B @ 270 hp.	190	.....	75	965	755	1,000	74,500	
Stits Aircraft *Riverside, Calif.*	Flut-R-Bug	2	26′ 0″	18′ 0″	6′ 0″	130	570	1,031	1 Con. @ 65 to 90 hp.	131	100	38	250	.....	.....	.....	Sold in kits
Streak-Aero Corp. *Hollydale, Calif.*	Streak 225	2	25′ 3″	22′ 6″	8′ 1″	.....	.....	1,965	1 Lyc. O435-A2 @ 225 hp	70	238	61	490	500	1,350	.....	
Taylorcraft, Inc. *Conway, Pa.*	Ranch Wagon	4	34′ 8″	24′ 4″	7′ 2″	179	1,700	2,750	1 Con. O470J @ 225 hp.	66	160	65	450	700	.....	9,840	
	Topper	1	34′ 8″	24′ 4″	7′ 2″	179	1,635	2,750	1 Con. O470J @ 225 hp.	44	115	75	900	900	.....	9,360	Agricultural duties
Temco Aircraft Corp. *Dallas 2, Tex.*	Riley Twin	4	33′ 5″	27′ 2″	9′ 7″	178	2,500	3,650	2 Lyc. O340-A1A @ 170 hp.	146	180	60	1,150	1,050	1200+	39,900	Fully equipped
	Model 58	2	33′ 3″	25′ 10″	9′ 10″	157	2,270	2,993	1 Lyc. GSO480-A1A @ 340 hp.	50	213	70	.....	.....	560	.....	
Transland Company *Los Angeles, Calif.*	Ag-2	1	42′ 0″	27′ 11″	9′ 8″	319	2,745	5,200	1 P&W R985 @ 450 hp.	125	150	48	1,200	1,000	.....	20,000	Farm & forest duties

Abbreviations:
AM — Aircooled Motors
Con. — Continental Motors Corp.
Kiek. — Kiekhaefer
Lyc. — Lycoming Division
P&W — Pratt & Whitney Aircraft
Tur. — Turbomeca

Note:
All data were supplied by the manufacturers; prices and other figures may be subject to change. In particular, CAA field length figures appear to be in some cases only rolling distances on the ground.

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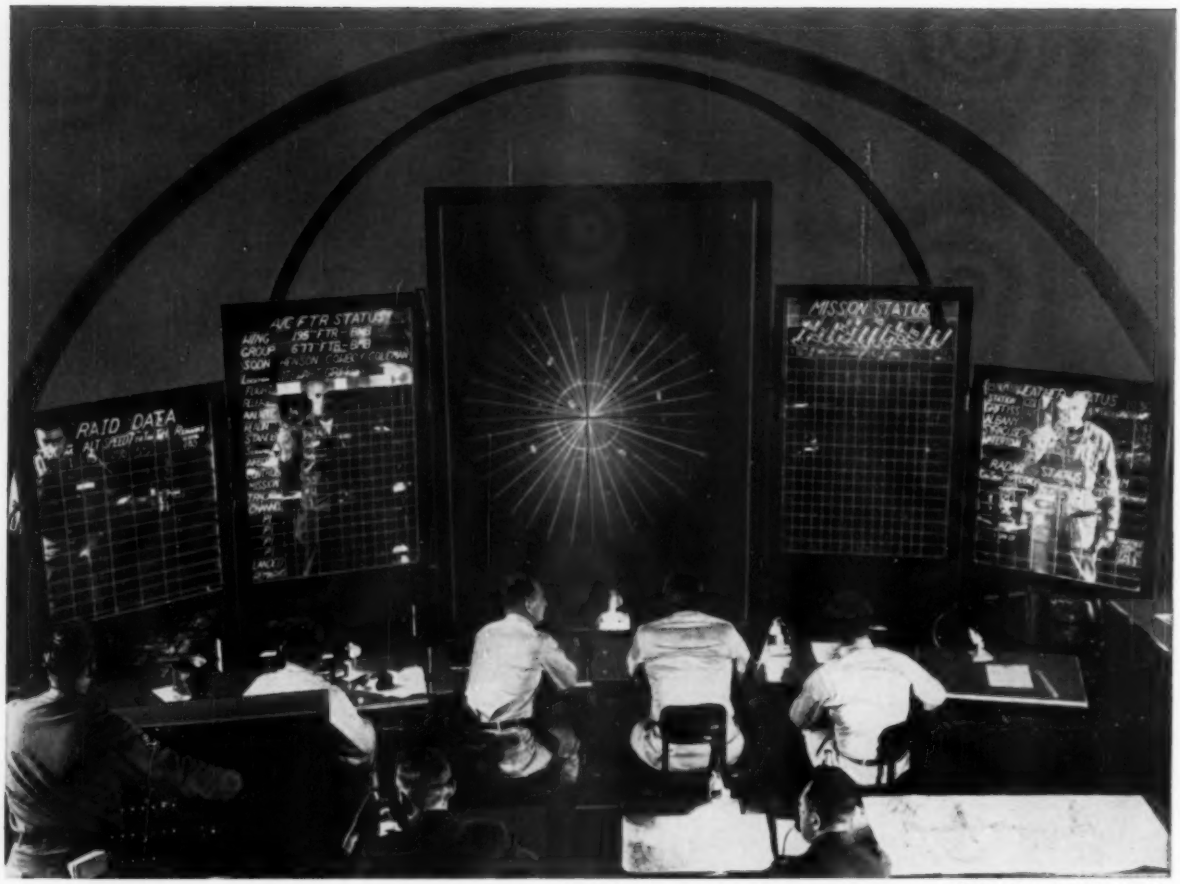


Official U.S. Air Force Photograph

Friend or foe? Tactical defense officers in MINK control center watch movements of aircraft as reported from radar warning sites. This is equipment developed under the direction of Rome Air Development Center.

ROME AIR DEVELOPMENT CENTER PROVIDES AIR DEFENSE EQUIPMENT FOR OUR AIR FORCE

One development agency for the Air Force's ground-based electronic equipment is Rome Air Development Center, located at Griffiss AFB in Rome, N. Y. One of the ten centers of the Air Research and Development Command, RADC is concerned with the air defense of our nation, with providing equipment for tactical supremacy, and with developing ground complexes for various navigation systems to aid all aircraft. In addition, RADC is charged with data handling improvements for the Air Force intelligence mission.

RADC is the responsible center for development, through its various contractors, of such end products as radar sites, including improved tubes, circuits, antennae, and shelters; ground communications equipment and associated support items; IFF (Identification Friend or Foe) environments, and electronic countermeasures.

Bringing complex systems from the written requirements to the actual hardware items to be used in the various Air Force commands is a long and tedious business which draws upon the skills of RADC's 500 civilian and military engineers and their many counterparts in private industry.

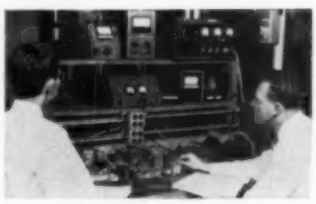
84

FORD INSTRUMENT COMPANY

DIVISION OF SPERRY RAND CORPORATION

31-10 Thomson Ave., Long Island City 1, N. Y.

This is one of a series of ads on the technical activities of the Department of Defense.



Engineers at Ford Instrument Company working on a special Air Force project in one of the company's laboratories.

U. S. Reciprocating Engines

Manufacturer and Address	Designation	No. of cylinders	Cylinder arrangement	Propeller drive	Power Ratings: Max. takeoff power (hp.) — SL	at rpm.	Normal cruise power (hp.)	at rpm.	at altitude (ft.)	Fuel	Diameter or dimensions, in (without reverse)	Rever ratio	Gross weight dry, lb
Aircooled Motors, Inc. *Syracuse, N. Y.*	4A4-99-B3	4	Ho	Direct	99	2,300	.....	.....	.....	80	.....	.....	209
	4A4-100-B3	4	Ho	Direct	100	2,550	.....	.....	.....	80	.....	.....	209
	6A4-150-B3	6	Ho	Direct	150	2,600	.....	.....	.....	80	.....	.....	278
	6A4-165-B3	6	Ho	Direct	165	2,800	.....	.....	.....	80	.....	.....	278
	6V4-178-B32, B33, O335-3, -4	6	Vo	Direct	178	3,000	.....	.....	.....	80	.....	.....	204
	6AG4-185-B12 ..	6	Ho	G .632:1	185	3,100	.....	.....	.....	80	.....	.....	232
	6A4-200-C6	6	Ho	Direct	200	3,100	.....	.....	.....	91	.....	.....	307
	6V4-200-C32[1], C33, O335-5, -6	6	Vo	Direct	200	3,100	.....	.....	.....	91	.....	.....	297
	6V6-245-B16[1] O 425-1	6	Vo	Direct	245	3,275	.....	.....	.....	80	.....	.....	372
Avco Manufacturing Corp. **Lycoming Division** *Stratford, Conn.*	O-235-C1 ..	4	Ho	Direct	115	2,800	80	2,350	6,500	80	22 53x32	.....	237
	O-290-D2B	4	Ho	Direct	140	2,800	100	2,350	6,500	80/87	22 81x32 24	.....	264
	O-320	4	Ho	Direct	150	2,700	110	2,450	7,000	80/87	23 12x32 24	.....	272
	O-340-A1A	4	Ho	Direct	170	2,700	125	2,450	7,000	91/96	24 68x32 55	.....	278
	O-360-A1A	4	Ho	Direct	180	2,700	135	2,450	7,500	91/96	24 68x33 57	.....	282
	O-435-A	6	Ho	Direct	190	2,550	140	2,300	7,000	80	29 59x32 24	.....	392
	GO-435-C2B, O-435-17	6	Ho	Gear	260	3,400	180	2,750	6,000	80/87	29 40x33 12	.....	430
	VO-435-A1B, O-435-23	6	Ho	Direct	260	3,400	200	3,200	7,000	80/87	25 19x33 32	.....	391
	GO-480-B1B	6	Ho	Gear	270	3,400	195	2,750	7,000	80/87	29 40x33 12	.....	430
	GO-480-F6	6	Ho	Gear	275	3,400	197	2,750	7,000	80/87	28 02x33 12	.....	442
	GO-480-D1A	6	Ho	Gear	275	3,400	197	2,750	7,000	80/87	26 34x33 12	.....	453
	GO-480-C2C6	6	Ho	Gear	295	3,400	210	2,750	6,500	100/130	28 02x33 12	.....	448
	GO-480-C1B6	6	Ho	Gear	295	3,400	210	2,750	7,000	100/130	26 34x33 12	.....	462
	GSO-480-A1A6	6	Ho	Gear	340	3,400	240	2,750	10,000	100/130	33 08x33 12	11 27	495
	SO-480	6	Ho	Direct	340	3,400	260	3,200	12,500	100/130	22 73x33 12	11 27	444
	SO-580A1A, O-580-3[1]	8	Ho	Direct	400	3,300	280	3,000	11,000	100/130	24 58x33 12	7 91	578
	GSO-580-D, O580-1	8	Ho	G .642:1	400	3,300	260	2,750	11,500	100/130	34 22x33 18	7 91	604
	VSO-580-A1A[1]	8	Ho	Direct	400	3,300	280	3,000	11,000	100/130	30 75x33 18	7 91	591
Continental Motors Corp. *Muskegon, Mich.*	A65-8	4	Ho	Direct	65	2,300	.....	.....	.....	73	.....	.....	170
	C85-12F	4	Ho	Direct	85	2,575	.....	.....	.....	73	.....	.....	182
	C90-12F	4	Ho	Direct	95	2,655	.....	.....	.....	80/87	.....	.....	186
	C125-2	6	Ho	Direct	125	2,550	.....	.....	.....	73	.....	.....	257
	O300 (C145-2)	6	Ho	Direct	145	2,700	.....	.....	.....	80/87	.....	.....	265
	E185	6	Ho	Direct	205	2,600	.....	.....	.....	80/87	.....	.....	355
	E225-8	6	Ho	Direct	225	2,650	.....	.....	.....	80/87	.....	.....	385
	O470-J	6	Ho	Direct	225	2,550	.....	.....	.....	80/87	.....	.....	415
	O470-K	6	Ho	Direct	230	2,600	.....	.....	.....	80/87	.....	.....	438
	O470-L	6	Ho	Direct	230	2,600	.....	.....	.....	80/87	.....	.....	438
	O470-M	6	Ho	Direct	240	2,600	.....	.....	.....	91/96	.....	.....	450
	FSO470	6	Ho	Direct	260	3,000	.....	.....	.....	91/96	.....	.....	565
	GSO526-A	6	Ho	G .688:1	320	3,000	.....	.....	.....	91/96	.....	.....	560
	GSO526-B	6	Ho	G .688:1	400	3,200	.....	.....	.....	100/130	.....	.....	548
Jacobs Aircraft Engine Co. *Pottstown, Pa.*	R755-A R755-11	7	Rad	Direct	300	2,200	.....	.....	.....	80	44	.....	505
	R755-B	7	Rad	Direct	275	2,200	.....	.....	.....	80	44	.....	505
	R755-EH[1]	7	Rad	.....	350	2,500	275	2,300	.....	91/98	44	.....	758
Pratt & Whitney Aircraft Div. **United Aircraft Corp.** *East Hartford, Conn.*	R2800-CA3	18	Rad	G .450:1	2,400	2,800	1,800	2,600	6,000	100/130	52 80	.....	2,317
	R2800-CB3	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52 80	.....	2,357
	R2800-CB4	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,500	108/135	52 80	.....	2,357
	R2800-CA15	18	Rad	G .450:1	2,400	2,800	1,800	2,600	6,000	100/130	52 80	.....	2,350
	R2800-CA18	18	Rad	G .450:1	2,400	2,800	1,800	2,600	6,000	100/130	52 80	.....	2,350
	R2800-CB16	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52 80	.....	2,390
	R2800-CB17	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,500	108/135	52 80	.....	2,390
Wright Aeronautical Div. **Curtiss-Wright Corp.** *Wood-Ridge, N. J.*	745C18BA3	18	Rad	G .4375:1	2,200	2,800	1,400	2,300	12,100	100/130	55 8	6 46[5]	2,780
	749C18BD1	18	Rad	G .4375:1	2,500	2,800	1,470	2,400	11,000	100/130	55 6	6 46[4]	2,944
	826C9HD3, & 5 R1820-76A,-76B	9	Rad	G .666:1	1,425	2,700	.....	.....	.....	100/130	54 95	7 21[3]	1,380
	826C9HD4 R1820-101	9	Rad	G .5625:1	1,425	2,700	.....	.....	.....	100/130	54 95	7 21[3]	1,380
	836C18CA1 R3350-26WA	18	Rad	G .4375:1	2,700	2,900	.....	.....	.....	115/145	55 6	6 46[4]	2,848
	853C7BA1 R1300-1A	7	Rad	G .5625:1	800	2,600	.....	.....	.....	91/98	50 45	7 21	1,065
	863C9HD1 R1820-103	9	Rad	Direct	1,425	2,700	.....	.....	.....	100/130	54 95	7 21[3]	1,380
	856TC18DA1, 2[6] R3350-30W	18	Rad	G .4375:1	3,250	2,900	.....	.....	.....	115/145	56 6	6 46[4]	3,408
	865C7BA1 R1300-2	7	Rad	Direct	800	2,600	.....	.....	.....	91/98	50 45	7 21	1,056
	866C9HE1 R1820-80	9	Rad	G .5625:1	1,475	2,800	.....	.....	.....	100/130	54 95	7 21	1,380
	867C9HE1 R1820-82	9	Rad	G .5625:1	1,525	2,800	.....	.....	.....	115/145	55 74	7 21	1,445
	871C7BA1[5] R1300-3	7	Rad	Direct	800	2,600	.....	.....	.....	91/98	50 45	7 21	1,080
	956C18CA1	18	Rad	G .4375:1	2,700	2,900	1,600	2,400	12,100	115/145	55 6	6 46[4]	2,957
	957C7BA1	7	Rad	G .5625:1	800	2,600	490	2,130	10,500	91/98	50 45	7 21	1,065
	968C9HE1	9	Rad	G .5625:1	1,475	2,800	890	2,400	13,000	100/130	54 95	7 21	1,390
	972TC18DA1, 2 R3350-34[6]	18	Rad	G .4375:1	3,250	2,900	1,910	2,400	11,400	115/145	56 6	6 46[4]	3,514
	975C18CB1	18	Rad	G .4375:1	2,800	2,900	1,600	2,400	12,500	115/145	56 6	6 46[4]	3,029
	976C9HE1	9	Rad	G .5625:1	1,535	2,800	890	2,400	12,200	100/130	55 75	7 21[3]	1,460
	988TC18EA-1 R3350-EA1	18	Rad	G .4375:1	3,400	2,900	1,910	2,400	13,500	115/145	56 59	6 46[3]	3,699
	988TC18EA2[7] R3350-EA2[7]	18	Rad	G .375:1	3,400	2,900	1,910	2,400	13,500	115/145	56 59	7 21[3]	3,745

G —Geared.
Ho —Horizontally opposed.
Rad —Radial.
SL —Sea level.
Vo —Vertically opposed.

[1] For helicopter installation.
[2] Or 10.14:1.
[3] Or 8.89:1.
[4] Or 8.67:1.
[5] 856TC18DB1 (R3350-30WA) is similar but has takeoff power (wet) of 3,500 hp. and dry gross weight of 3,445 lb. 868TC18DB1 (R3350-88) is similar to -30WA but weighs 3,438 lb. dry. Some have manifold absolute pressure regulator.
[6] Military engine rated at 3,700 hp. max.
[7] EA3 is same as EA1 except for modified baffles and fuel injection line routing.

research*

development

design

production

Hoffman
LABORATORIES, INC.

A SUBSIDIARY OF HOFFMAN ELECTRONICS CORPORATION

INTEGRATED ELECTRONICS

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THE SKILLS FOR PRODUCTION

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Missile Guidance & Control Systems
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Leading Foreign Aircraft Military and Civil

Manufacturer and address	Model designation	Aircraft name	Primary mission	Max. no. of crew	Max. no. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
ARGENTINA													
Industrias Aeronauticas y Mecanicas del Estado	.....	Pulqui 2	Fighter	1	0	34.8	38.1	10.4	.....	5,720	12,100	1 R-R Nene 2 @ 5,000 lb. t.	654
	I.A. 35	Justicialista del Aire	Multi	11	.....	.....	45.8	.....	.....	7,700	12,500	2 IAR-19C Indio	220
AUSTRALIA													
Commonwealth Aircraft Corp. Pty., Ltd.	C.A. 25	Winjeel	Trainer	3	0	38.8	27.2	9.6	249	3,240	4,235	1 P&W R985-SB-3 @ 450 hp.	18
	C.A. 27	Sabre Mk. 30	Fighter	1	0	37.1	37.5	14.7	288	11,000	20,000	1 R-R Avon 20 @ 7,500 lb. t.	70
Government Aircraft Factories	.....	Canberra 20	Bomber	2	0	64.0	65.5	15.6	960	.....	51,000	2 R-R Avon	...
CANADA													
Avro Aircraft, Ltd.	CF-100 Mk. 4	.....	AW F't'r.	2	0	57.5	54.2	14.6	540	.....	37,000	2 Orenda 11 @ 7,000 lb. t.	
	CF-105	.....	AW F't'r.	.....	.....	54.0	.....	.....	.....	.....	52,000	2 Orenda PS13 @ 20,000 lb. t.	M>1
Canadair, Ltd.	.....	Sabre 5	Fighter	1	0	37.9	37.0	14.0	.....	.....	.....	1 Orenda @ 6,500 lb. t.	700
De Havilland Aircraft of Canada, Ltd.	D.H.C. 2	Beaver	Transport	2	7	48.0	30.0	10.5	250	2,804	5,100	1 P&W R985 @ 450 hp.	163
	D.H.C. 3	Otter	Transport	2	14	58.0	41.8	13.0	375	4,138	8,000	1 P&W R1340 @ 600 hp.	160
	D.H.C. 1	Chipmunk	Trainer	2	1	34.3	25.4	7.0	173	1,373	2,000	1 Gypsy Major Series 10 @ 145 hp.	134
FRANCE													
Constructions Aeronautiques du Bearn	.....	Supercab	Pers.	1	1	27.0	18.0	5.6	108	880	1,350	1 Con. @ 90 hp.	175
Avions Boisavia	B605	Mercury	Pers.	1	3	37.5	23.5	7.5	194	1,430	2,575	1 Sneema 4LO2 @ 170 hp.	155
S. A. des Ateliers d'Aviation Louis Breguet	763	Deux Ponts	Transport	3	107	140.8	94.9	31.4	1,965	68,150	113,500	4 P&W CA-18 @ 2,400 hp.	272
Generale Aeronautique Marcel Dassault	MD-452-II-C	Mystere 2	Fighter	1	0	38.3	38.7	14.0	326	11,490	16,408	1 Sneema Atar 101-D-1 @ 6,600 lb. t.	660
	MD-452-IV-A	Mystere 4A	Fighter	1	0	36.7	42.4	14.5	344	12,492	16,280	1 HS Verdon R-450 @ 7,700 l. t.	700
	MD-452-IVB2	Super Mystere	Fighter	1	0	.....	.....	.....	.....	.....	.....	1 Sneema Atar 101-G @ 9,700 lb. t.	M>1
	.....	Mystere 22	Fighter	1	0	.....	.....	.....	.....	.....	12,000	2 Turb. Gabizo @ 2,200 lb. t.	...
	.....	Mystere 24	Fighter	1	0	.....	.....	.....	.....	.....	.....	1 Sneema Atar 101-G @ 9,700 lb. t.	...
	.....	Mystere 26	Fighter	1	0	.....	.....	.....	.....	.....	.....	2 Br. Orpheus @ 4,850 lb. t.	...
	MD-550	Mirage	Intereceptor	1	0	.....	.....	.....	.....	.....	.....	2 AS Viper + 1 SEPR rocket	M>1
Avions Hurel-Dubois	H.D. 32	.....	Transport	3	44	147.6	72.2	21.8	.....	24,625	39,600	2 P&W R1830 @ 1,200 hp.	211
Farman	.....	Monitor 3	Trainer	2	0	32.7	23.0	7.2	151	1,232	1,804	1 Sneema 4L26 @ 170 hp.	150
Ets. Fouga & Cie.	C.M. 170R	Magister	Trainer	2	0	37.3	33.0	9.2	186	4,260	6,160	2 Turb. Marbore 2 @ 880 lb. t.	455
Rene LeDuc	O. 21	.....	Fighter	1	0	38.2	40.2	9.1	.....	8,360	13,200	1 LeDuc rj. @ 44,000 lb. t.	655
Soc. Max Holste	M.H. 1521	Broussard	Pers.	1	6	45.0	28.0	9.3	273	3,190	5,500	1 P&W R985 @ 450 hp.	175
Soc. Morane-Saulnier	M.S. 733	Alcyon	Trainer	3	0	37.0	31.1	11.4	236	2,830	4,250	1 Potez 6-D30 @ 240 hp.	164
	M.S. 760	Paris	Liaison	4	0	33.3	32.9	8.6	194	4,320	7,500	2 Turb. Marbore 2 @ 880 lb. t.	405
Soc. Industrielle pour l'Aeronautique	S. 200	Minijet	Trainer	2	0	26.2	16.9	5.9	103	1,060	1,805	1 Turb. Palas @ 350 lb. t.	240
	S. 300	Primijet	Trainer	2	0	26.2	22.1	8.5	103	1,155	1,935	1 Turb. Palas @ 350 lb. t.	225
	S. 1000	Cocinelle	Pers.	2	.....	29.6	18.8	8.2	139	815	1,355	1 Con. C 90-12F	124
Societe Payen-Aviations	PA-49	.....	Exp.	1	0	17.0	16.9	7.2	121	1,005	1,430	1 Turb. Palas @ 350 lb. t.	310
Soc. des Avions & Moteurs Henri Potez	Potez 75	.....	Attack	2	0	42.7	32.9	8.9	247	3,960	5,280	1 Potez 8D32 @ 450 hp.	175
Soc. Nat. de Constructions Aeronautiques du Nord	NC-856A	Norvigie	Obs.	3	0	39.6	25.0	7.2	182	1,485	2,530	1 Sneema Regnier 4LO4 @ 147 hp.	120
	Nord 2501	Noratlas	Trans.	3	42	107.0	72.0	10.1	1,083	28,600	48,400	2 Sneema Hercules @ 2,040 hp.	275
	Nord 3200	.....	Trainer	2	0	32.0	26.3	10.0	.....	2,050	2,700	1 Salmson 8 AS @ 260 hp.	175
	Nord 1402 B	Gerfaut	Fighter	1	0	.....	.....	.....	.....	.....	.....	1 Sneema Atar	...
	Nord 1502	Griffon	Intereceptor	1	0	21.5	32.6	.....	.....	.....	9,000	1 Sneema Atar 101-G @ 9,700 lb. t.	M>1

Abbreviations:

Al. — Alvis
A-S — Armstrong Siddeley
ASW — Anti-submarine warfare
AW — All-weather
Bl. — Blackburn
Br. — Bristol
Con. — Continental
DH — de Havilland
eshp. — Equivalent shaft horsepower
hp. — Horsepower
HS — Hispano-Suiza
lb. t. — Pounds thrust
Lyc. — Lycoming
M>1 — Supersonic
P&W — Pratt & Whitney
R-R — Rolls-Royce
Sven. — Svenska Flygmotor
Turb. — Turbomeca
Wr. — Wright

HOMEWARD BOUND
On target and homeward bound . . . the success of any mission depends on precise navigation. With ceiling zero and radiation prohibited, a self-contained system is mandatory. When yours is the responsibility for specifying this equipment, look to Kearfott for the most advanced gyro and inertial systems or their components.
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A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

Leading Foreign Aircraft Military and Civil

Manufacturer and address	Model designation	Aircraft name	Primary mission	Max. no. of crew	Max. no. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Soc. Nat. de Constructions Aeronautiques du Sud-Est	S.E. 210	Caravelle	Trans.	4	70	112.5	104 8	28 .5	1,579	49,500	90,400	2 R-R Avon @ 10,500 lb. t.	465
	S.E. 5000	Baroudeur	Fighter	1	0	32.9	44 3	11 .7	272	10,260	13,945	1 Snecma Atar 101D @ 6,160 lb. t.	650
	.....	Aquilon	Fighter	2	0	43.0	36 .8	8 .9	.....	10,750	14,950	1 DH Ghost @ 4,840 lb. t.	585
Soc. Nat. de Constructions Aeronautiques du Sud-Ouest	S.O. 4050	Vautour	Attack	2	0	50	50	15	485	.....	30,000	2 Snecma Atar 101E3 @ 7,720 lb. t.	680
	S.O. 9000	Trident	Fighter	1	0	25	42	....	177	.....	12,000	3 SEPR 25 rockets @ 9,900 lb. t.	M>1
GREAT BRITAIN													
Sir W. G. Armstrong-Whitworth Aircraft, Ltd.	.....	Sea Hawk F.G.A. 4	Fighter	1	0	39 .0	40 .0	....	.....	.....	.....	1 R-R Nene	.....
	.....	Meteor N.F. 14	AW F't'r.	2	0	43 .0	49 .9	.....	.....	.....	.....	2 R-R Derwent	.....
Auster Aircraft, Ltd.	J5B	Autocar	Pers.	1	3	36 .0	23 .2	6 .5	185	.....	2,400	1 DH Gipsy Major 1 @ 130 hp.	117
	J5F	Aiglet	Trainer	1	3	32 .0	23 .2	6 .5	164	1,380	2,200	1 DH Gipsy Major 1 @ 130 hp.	125
	A.O.P. Mk. 6	.....	Obs.	2	0	36 .0	23 .8	8 .6	185	1,417	2,105	1 DH Gipsy Major 7 @ 145 hp.	123
	A.O.P. Mk. 9	.....	Obs.	3	0	36 .5	23 .6	8 .9	198	1,558	2,100	1 Bl. Bombardier @ 180 hp.	127
	B8	Agricola	Agricultural	1	2	42 .0	27 .5	8 .3	254 .7	.....	3,280	1 Continental O-470-M @ 240 hp.	.....
Aviation Traders, Ltd.	.....	Accountant	Trans.	2	28	82 .5	60 .5	24 .1	632	14,823	28,000	2 R-R Dart 6	290
Blackburn & General Aircraft, Ltd.	G.A.L. 60	Beverley	Trans.	4	162	162 .0	99 .5	37 .5	2,916	84,740	143,000	4 Bris. Centaurus @ 3,150 hp.	243
	.....	Universal	Trans.	2	155	162 .0	99 .5	37 .5	2,916	81,740	143,000	4 Bris. Centaurus @ 3,150 hp.	243
Bristol Aircraft	170 Mk. 31M	Mil. Freighter	Trans.	2	0	108 .0	68 .3	21 .5	1,487	27,110	46,000	2 Bris. Hercules 734 @ 1,980 hp.	303
	175	Britannia 100	Trans.	9	92	142 .3	114 .0	36 .7	2,075	84,000	150,000	4 Bris. Proteus 705 @ 3,780 eshp.	380
	.....	Britannia 300	Trans.	9	101	142 .3	124 .3	36 .7	2,075	85,000	155,000	4 Bris. Proteus 755 @ 4,120 eshp.	418
	.....	Britannia 310	Trans.	9	93	142 .3	124 .3	36 .7	2,075	83,250	170,000	4 Bris. Proteus 755 @ 4,120 eshp.	418
	.....	Britannia 250	Freight and Pass.	9	84	142 .3	124 .3	36 .7	2,075	84,850	170,000	4 Bris. Proteus 755 @ 4,120 eshp.	418
Boulton Paul Aircraft, Ltd.	P. 108A	Balliol T. 2	Trainer	2	0	35 .1	39 .1	12 .5	250	6,730	8,410	1 R-R Merlin 35 @ 1,280 hp.	292
	P. 111A	.....	Exp.	1	0	33 .5	26 .1	12 .6	.....	.....	.....	1 R-R Nene	.....
De Havilland Aircraft Co., Ltd.	.....	Vampire Trainer	Trainer	2	0	38 .0	34 .5	6 .5	261	.....	12,920	1 DH Goblin 35 @ 3,500 lb. t.	549
	.....	Chipmunk Mk. 20	Trainer	2	0	34 .3	25 .4	7 .0	173	1,425	2,100	1 DH Gipsy Major 8 @ 145 hp.	134
	.....	Venom Mk. 3	AW F't'r.	2	0	42 .8	36 .6	8 .5	.....	.....	.....	1 DH Ghost 104	.....
	.....	Venom F.B. Mk. 4	Fighter	1	0	38 .3	33 .0	6 .5	.....	.....	.....	1 DH Ghost 104	.....
	.....	Sea Venom Mk. 21	AW F't'r.	2	0	42 .8	36 .6	8 .5	.....	.....	.....	1 DH Ghost 104	.....
	D.H. 110	.....	.....	2	0	51 .0	52 .1	10 .1	.....	.....	.....	2 R-R Avon	.....
	.....	Dove	Trans.	2	6	57 .0	39 .3	13 .3	335	6,040	8,800	2 DH Gipsy Queen 70 @ 380 hp.	200
	D.H. 106	Comet 2	Mil. Trans.	5	44	115 .0	96 .0	28 .5	2,015	54,700	120,000	4 R-R Avon @ 7,350 lb. t.	*480
	D.H. 106	Comet 3	Trans.	6	58	115 .0	111 .5	28 .5	2,121	.....	150,000	4 R-R Avon @ 10,000 lb. t.	.....
	.....	Heron 2	Trans.	2	...	71 .5	48 .5	15 .6	499	8,284	13,500	4 DH Gipsy Queen 30 @ 250 hp.	191
	D.H. 106	Comet 4	Trans.	5	60-76	115 .0	111 .5	28 .5	2,121	68,400	152,500	4 R-R Avon @ 10,500	*500
English Electric Co., Ltd.	.....	Canberra B. 8	Bomber	2	0	64 .0	65 .5	15 .6	.....	.....	.....	2 R-R Avon	.....
	P. 1	.....	Fighter	1	0	.....	.....	.....	.....	.....	.....	2 A-S Sapphire	.....
Fairey Aviation Co., Ltd.	.....	Gannet A.S. Mk. 1	ASW	3	0	54 .3	43 .0	13.	.....	.....	.....	1 A-S Double Mamba 100 @ 2,950 eshp.	.....
	.....	Gannet Mk. 2	Trainer	4	0	54 .3	43 .0	13 .7	.....	.....	.....	1 A-S Double Mamba 100 @ 2,950 eshp.	.....
	.....	Delta	Res.	1	0	26 .8	51 .7	11 .0	.....	.....	.....	1 R-R Avon	.....
Folland Aircraft, Ltd.	.....	Midge	.....	1	0	20 .6	28 .8	.....	.....	.....	4,500	1 A-S Viper 101 @ 1,640 lb. t.	.....
	.....	Gnat	Inter.	1	0	22 .1	29 .8	8 .8	137	3,994	6,357	1 Bris. Orpheus	.....
Gloster Aircraft Co., Ltd.	.....	Meteor F.R. 9	Fighter	1	0	37 .1	43 .5	13 .0	350	10,768	15,660	2 R-R Derwent 8 @ 3,500 lb. t.	595
	.....	Meteor P.R. 10	Photo	...	0	43 .0	44 .3	.....	.....	.....	.....	2 R-R Derwent 8 @ 3,500 lb. t.	575
	.....	Javelin F.A.W. 1	AW F't'r.	2	0	52 .0	57 .0	16 .3	920	.....	27,000	2 A-S Sapphire	.....
Handley Page, Ltd.	H.P. 80	Victor B. 1	Bomber	...	0	110 .0	114 .9	26 .8	.....	.....	.....	4 A-S Sapphire	.....
	H.P.R. 3	Herald	Trans.	2	44	95 .0	70 .3	22 .5	882	20,322	34,000	4 Alvis Leonides Major @ 870 hp.	246
Hawker Aircraft, Ltd.	P. 1067	Hunter F. 4	Fighter	1	0	33 .8	45 .9	13 .2	.....	.....	.....	1 R-R Avon RA21 @ 8,000 lb. t.	.....
	P. 1067	Hunter F. 6	Fighter	1	0	33 .8	45 .9	13 .2	.....	.....	.....	1 R-R Avon RA28 @ 10,000 lb. t.	.....

* Cruising Speed

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Sven. — Svenska Flygmotor
Wr. — Wright

• SPECIFICATIONS

Leading Foreign Aircraft Military and Civil

Manufacturer and address	Model designation	Aircraft name	Primary mission	Max. no. of crew	Max. no. of passengers	Overall wingspan ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Hunting Percival Aircraft, Ltd.	.....	Pembroke	Multi	2	10	64 5	46 0	16 0	400	.....	13,000	2 Alvis Leonides @ 550 hp.	220
	.....	Provost T. Mk. 1	Trainer	2	0	35 2	28 8	12 2	214	.....	4,400	1 Alvis Leonides @ 550 hp.	201
	.....	Jet Provost T. Mk. 1	Trainer	2	0	35 6	31 9	12 8	214	.....	6,750	1 A-S Viper @ 1,750 hp.	324
A. V. Roe & Co., Ltd.	696	Shackleton M.R. 3	ASW	10	0	120 5	87 3	23 3	.....	.....	.....	4 R-R Griffon	.....
	698	Vulcan B. 1	Bomber	.....	.....	99 0	97 0	26 5	.....	.....	.....	4 Br. Olympus	.....
Scottish Aviation, Ltd.	.....	Pioneer CC Mk. 1	Comm.	1	4	49 8	34 4	10 4	390	3,993	5,800	1 Alvis Leonides 502/7 @ 540 hp.	160
	.....	Twin Pioneer	Trans.	1	16	76 5	45 3	12 3	670	8,732	13,500	2 Alvis Leonides 503 @ 540 hp.	180
Short Bros. & Harland, Ltd.	S.B. 5	.....	Res.	1	0	30 5	45 8	...	.....	.....	.....	1 R-R Derwent	.....
	S.B. 4	Sherpa	Res.	1	0	38 0	31 9	9 1	.....	.....	.....	2 Turb. @ 350 lb. t.	.....
	S.B. 6	Seamew A.S. 1	ASW	3	0	55 0	41 0	15 8	.....	.....	.....	1 A-S Mamba	.....
Vickers-Armstrongs Ltd.	.....	Swift F. Mk. 5	Fighter	1	0	32 3	41 5	12 3	.....	.....	.....	1 R-R Avon RA-7R @ 9,500 lb. t.	.....
	.....	Valiant B. Mk. 1	Bomber	5	.....	114 3	108 3	...	.....	.....	.....	1 R-R Avon RA-14 @ 9,500 lb. t.	.....
	V. 700	Viscount	Trans.	3	40-53	93 8	81 2	26 8	963	36,700	60,000	4 R-R Dart @ 1,740 eshp.	328
	V. 800	Viscount	Trans.	3	52-65	94 0	85 0	26 8	963	39,309	60,050	4 R-R Dart @ 1,740 eshp.	320
	V. 900	Vanguard	Trans.	3	93-105	118 0	118 1	34 9	1,527	71,200	135,000	4 R-R Tyne @ 4,470 eshp.	388
	N. 113	.....	Fighter	1	.....	.....	.....	.....	.....	.....	.....	2 R-R Avon	.....
Westland Aircraft, Ltd.	W. 35	Wyvern S. 4	Strike	1	.....	44 0	41 9	14 5	355	15,290	24,300	1 A-S Python 3 @ 4,110 eshp.	.....
HOLLAND													
Royal Dutch Aircraft Factories (Fokker)	S. 11	Instructor	Trainer	2	0	36 1	27 0	7 9	199	1,785	2,425	1 Lyc. O-435-A @ 190 hp.	130
	S. 13	Universal Trainer	Trainer	2	0	63 0	44 6	18 0	495	9,225	12,730	2 P&W R1340 @ 600 hp.	220
	S. 14	Mach Trainer	Trainer	2	0	39 5	43 7	15 3	342	8,300	11,800	1 R-R Derwent 8 @ 3,470 lb. t.	455
	S. 14-2	Mach Trainer	Trainer	2	0	39 5	43 7	15 3	342	.....	12,350	1 R-R Nene 2 @ 5,100 lb. t.	530
	F. 27	Friendship	Transport	3	36	95 0	73 0	26 5	754	20,610	34,200	2 R-R Dart @ 1,680 eshp.	280
ITALY													
S. A. I. Ambrosini	S. 7	Supersette	Personal	2	0	28 8	28 8	9 2	138	2,365	3,050	1 Alfa Romeo 115 @ 230 hp.	173
	F. 4	Rondone	Personal	2	0	28 3	20 2	9 2	114	748	1,210	1 Walter Mikron @ 65 hp.	140
Soc. Aero Caproni	F. 5	.....	Trainer	2	0	25 8	21 8	8 0	107	1,032	1,650	1 Turbomeca Palas @ 330 lb. t.	242
Fiat—Stabilimento Velivoli	G. 46-2B	.....	Trainer	2	0	34 2	27 9	7 9	172	2,450	3,150	1 DH Gipsy Queen @ 245 hp.	204
	G. 46-4B	.....	Trainer	2	0	34 2	27 9	7 9	172	2,425	3,145	1 Alfa Romeo 115 @ 222 hp.	194
	G. 49-1	.....	Trainer	2	0	40 9	31 5	9 1	255	4,700	5,955	1 Alvis Leonides @ 570 hp.	225
	G. 49-2	.....	Trainer	2	0	40 9	30 9	9 0	255	4,700	5,955	1 P&W R1340 @ 600 hp.	230
	G. 59-4A	.....	Trainer	1	0	38 9	31 1	12 1	227	6,180	7,630	1 R-R Merlin @ 1,400 hp.	380
	G. 59-4B	.....	Trainer	2	0	38 9	31 1	12 1	227	6,285	7,465	1 R-R Merlin @ 1,400 hp.	380
	G. 80-3B	.....	Trainer	2	0	36 1	42 4	13 3	271	9,500	12,800	1 DH Goblin 35 @ 3,500 lb. t.	515
	G. 82	.....	Trainer	2	0	36 1	42 5	13 5	271	9,700	13,800	1 R-R Nene @ 5,400 lb. t.	575
	G. 91	.....	Fighter	1	0	.....	.....	.....	.....	.....	.....	1 Br. Orpheus	.....
Aeronautica Macchi	M.B. 308	.....	Personal	2	0	32 8	21 4	7 1	148	915	1,433	1 Con. C85 @ 85 hp.	118
	M.B. 320	.....	Personal	1	5	42 6	28 4	10 5	227	3,284	4,960	2 Con. E185 @ 185 hp.	200
	M.B. 323	.....	Trainer	1	0	39 5	30 0	13 3	216	4,245	5,500	1 P&W R1340-S1H1 @ 610 hp.	236
	M.B. 326	.....	Trainer	2	0	31 5	33 0	5 3	197	3,803	6,371	1 A-S Viper ASV5 @ 1,640 lb. t.	449
Nardi Soc. A. per Costruzioni Aeronautiche	F.N. 333	.....	Personal	1	3	32 7	23 0	8 8	155	1,635	2,980	1 Con. O470-B @ 240 hp.	180
Piaggio & Co. s. p. a.	P. 136-L	.....	Personal	1	4	44 4	35 4	12 6	270	4,430	6,400	2 Lyc. GO-480-B @ 275 hp.	182
	P. 148	.....	Trainer	2	0	36 5	27 7	7 9	203	1,931	2,645	1 Lyc. O-435-A @ 190 hp.	145
	P. 149	.....	Personal	1	3	36 5	28 1	9 5	203	2,560	3,700	1 Lyc. GO-480-B @ 275 hp.	187
	P. 150	.....	Trainer	2	0	42 3	30 8	9 2	271	4,365	5,600	1 P&W R1340-S3H1 @ 600 hp.	236
SWEDEN													
Svenska Aeroplan A. B.	Saab-29	J-29	Fighter	1	0	36 1	33 2	12 3	258	9,480	13,360	1 Sven. RM-2 @ 5,000 lb. t.	660
	Saab-32	Lansen	AW F't'r.	2	0	42 7	48 1	15 7	....	15,500	22,000	1 Sven. RM-5 @ 9,500 lb. t.	700
	Saab-90A-2	Scandia	Transport	3	40	91 9	69 9	23 3	922	21,960	35,270	2 P&W R2180-E1 @ 1,800 hp.	277
	Saab-91B	Safir	Trainer	3	0	34 8	26 0	7 2	146	1,580	2,315	1 Lyc. O-435-A @ 190 hp.	170
	Saab-91C	Safir	Personal	1	3	34 8	26 0	7 2	146	1,625	2,685	1 Lyc. O-435-A @ 190 hp.	169
	Saab-210	Draken	Research	1	0	.....	.....	.....	.....	.....	.....	1 A-S Adder @ 1,050 lb. t.	.....
	Saab-35	Draken	Fighter	1	0	50	35	.....	.....	.....	.....	1 R-R Avon RA-28 @ 10,000 lb. t.	M>1

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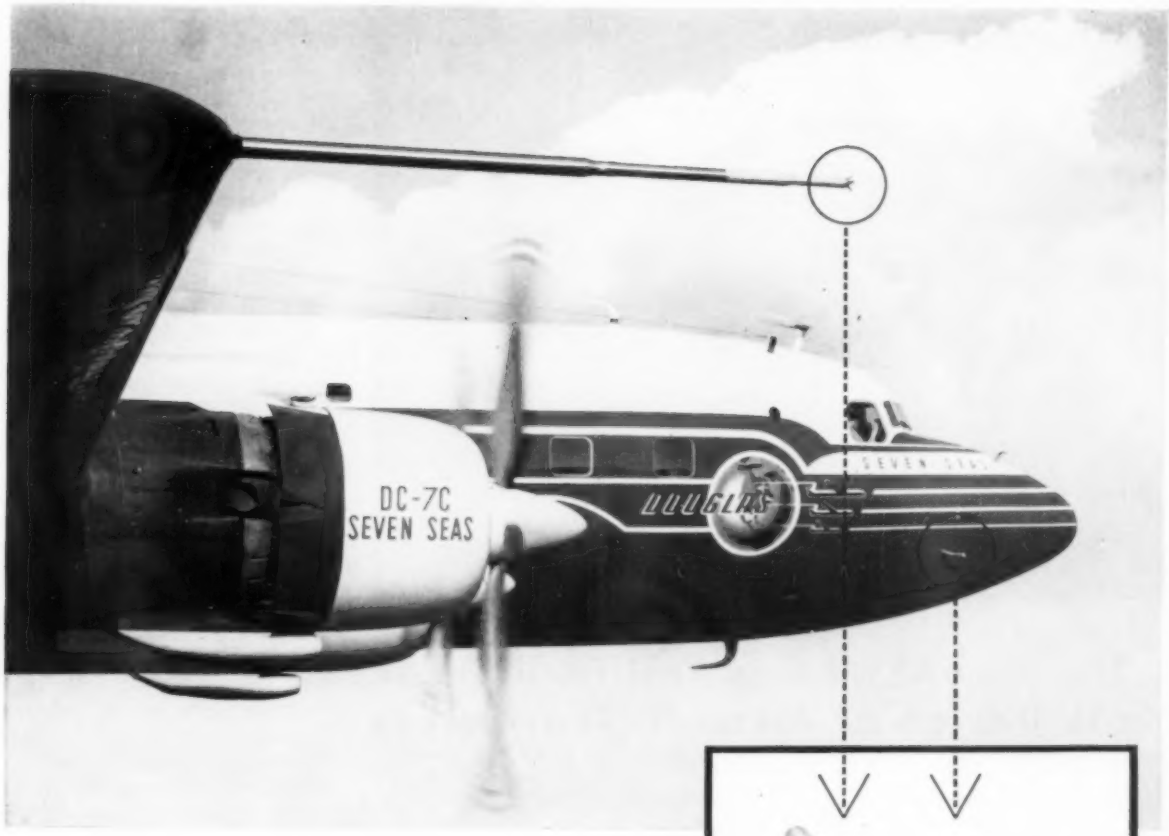
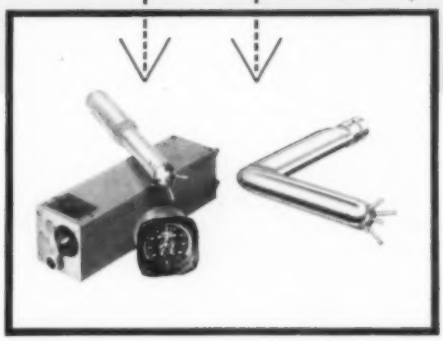


ANNOUNCING

A CRUISE CONTROL SYSTEM WITH NO MOVING PARTS...

The Giannini-Douglas Differential Pressure Flight Angle Computer



Differential pressure probes *with no moving parts* sense cruise control air data on Douglas Aircraft's newest overseas transport, the DC-7C. The probes are an integral part of a completely new angle-of-attack measuring system, the Giannini-Douglas Differential Pressure Flight Angle Computer, which was designed to have the greatest reliability and longest operating life possible in a cruise control sensing instrument.

In the Giannini-Douglas developed unit, small impact probes are accurately positioned on the head of a short stub boom mounted on the side of the fuselage; or for flight test, on a free airstream boom. The probes are connected to sensitive Giannini pressure transducers which supply electrical signals proportional to air data to a passive network computer having no vacuum tubes. The output of this integrating unit can be fed directly into an automatic flight control system or can be used to activate a panel indicator.

System accuracy in the control range is $\pm 0.1°$ to $\pm 0.2°$ and angle of attack data can be sensed over a range of $\pm 20°$ from Mach 0.3 to 2.0. Less than 0.25 ampere at standard aircraft voltage is required for continuous operation.

Thoroughly proven in wind tunnel and flight test, the Giannini-Douglas Differential Pressure Flight Angle Computer is one more outstanding example of recent advances in aeronautical progress made possible by the ingenuity and skill of today's research and design engineers in the field of avionics.

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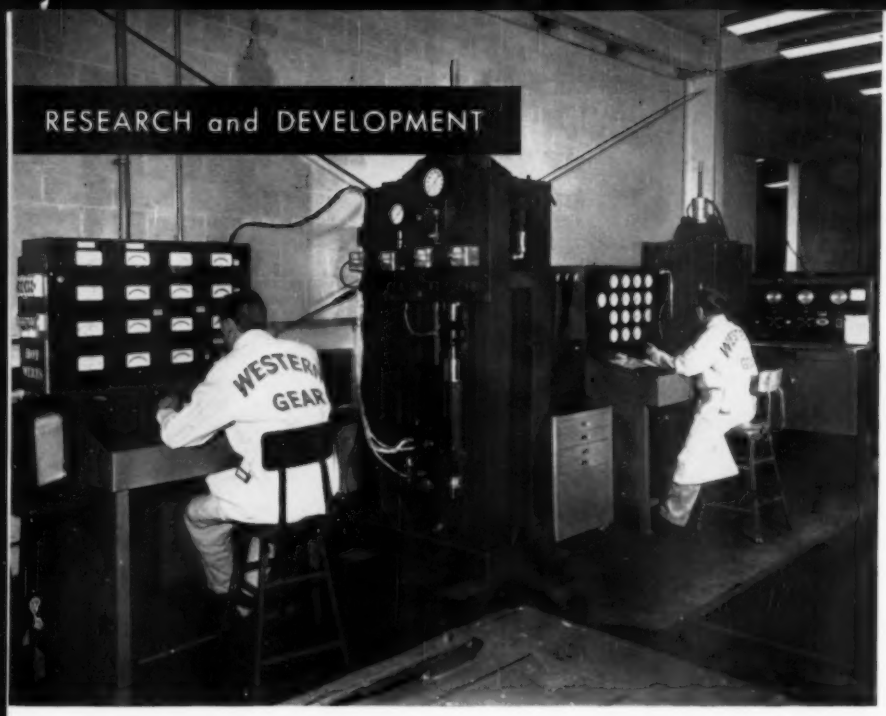


The Role of Modern Test Facilities in the Design of Aircraft Gear Drives

by John Morris

Manager of Engineering, Western Gear Corporation

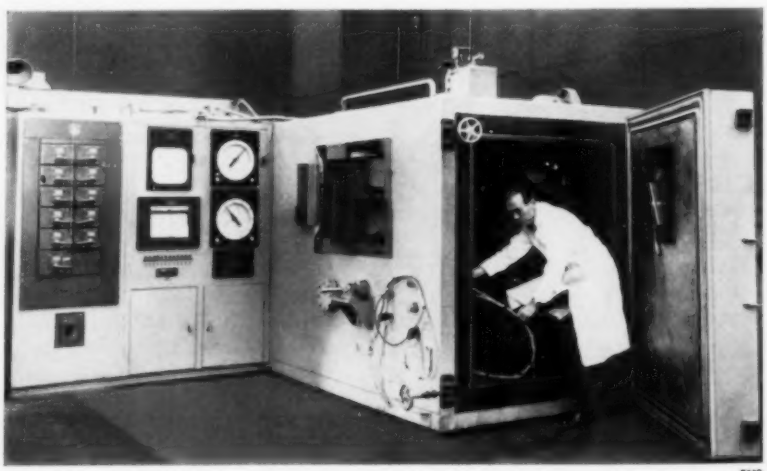
Modern aircraft, whether it be piloted or electronically guided, requires mechanical devices of utmost reliability. No longer can the designer depend entirely upon experience but must have available extensive equipment capable of producing the environments and loading conditions which will check the newly designed parts to the conditions encountered on its assigned mission.

This environmental test equipment must be operated by experienced personnel under the guidance of engineers capable of correlating and analyzing test results and their actual relation to final installations before a suitable product can be designed, produced, and proven. Mother Nature in her unlimited weather laboratory produces extreme variations of the elements in almost incalculable combinations. The laboratory must endeavor to precisely duplicate conditions. Altitude chambers at Western Gear Corporation (as shown in the photo at lower right) can carry the test part to the extremes of altitude beyond the reaches of piloted flight up to and in excess of 90,000 ft. Temperatures must be duplicated far below those normally encountered by present day military craft. Tests have been run at Western Gear as low as –300° F.

The salt spray of the sea and the steaming humidity of the jungle as well as the wind and dust of the desert are being duplicated daily in our block-long test laboratory. The tremendous speeds as well as the necessity for the utmost in control produce forces in any direction which are simulated in Western Gear centrifuges in excess of 100 times the normal weight of the part. Studies of the reaction to shock loadings are duplicated in our laboratory by impact tests often running in excess of 200 G's.

The effects of wind, sand, dust, rain, sunshine, snow, heat, cold, vibration, impact, chemicals, lubricants and materials must be evaluated while constantly striving to increase load carrying ability, serviceability and reliability of products. Extensive testing is required to assure that no possible condition has been overlooked which may cause a malfunction. An example of a test stand setup to check the operational characteristics for testing linear actuators is shown at upper left. The interrelation of magnetism, electricity, gravity, vibrations, forces, materials and chemicals under environmental conditions often poses the necessity of multitudes of carefully controlled, precisely measured tests.

Western Gear engineering recognizes these very necessary elements. Therefore, in our block-long testing laboratory the most modern equipment is provided to prove design concepts. Thus meticulous attention to perfection has made Western Gear the leader in the field of aircraft gearing and systems design. Why not let us assist you in your next power transmission problem? Western Gear Corporation, General Offices, P.O. Box 182, Lynwood, California.



Leading Foreign Rotary-Wing Aircraft

Basic Data				Dimensions			Weights		Powerplant		Performance					Remarks
Manufacturer and address	Designation	Name	Seats, incl. crew	Rotor diameter, ft.	Length, blades unfolded, ft.	Max. height to rotor top, ft.	Weight empty, lb.	Normal gross weight, lb	Number, manufacturer, designation and max. rating of powerplant	Fuel capacity, gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Hovering ceiling in ground effect, ft.	Service ceiling, ft.	Maximum still-air range, mi.	
GREAT BRITAIN																
Bristol Aeroplane Co., Ltd. *Filton, Bristol*	171 Mk. 4	Sycamore	5	48.6	61.40	10.2	4,150	5,400	1 Al. Leonides 524/1 @ 520 hp.	78	127	1,300	8,400	15,500	272	
	173 Mk. 3	.....	16	48.6	89.75	17.0	9,714	13,496	2 Al. Leonides Major @ 1,740 hp.	290	127	1,400	10,000	16,000	348	Development for MoS military copter
Fairey Aviation Co., Ltd. *Hayes, Middlesex*	.....	Rotodyne	46	90.0	.....	22.2	.....	33,000	2 Napier Eland @ 3,000 eshp. and 4 Fairey Pressure Jets (Rotor Tip)	.....	.....	.....	.....	.....	250	Two prototypes bought by MoS
	.....	Jet Gyrodyne	4	60.0	.....	.....	.....	.....	1 Alvis Leonides @ 525 hp. and 2 Fairey Pressure Jets (Rotor Tip)	.....	.....	.....	.....	.....	.....	Rotor head is similar to Rotodyne
	.....	Ultra Light Helicopter	2	28.0	.....	.....	.....	.....	1 Blackburn Palouste @ 260 ghp. and 2 Fairey Pressure Jets (Rotor Tip)	.....	.....	.....	.....	.....	.....	A.O.P. and reconnaissance aircraft for British Army
Hunting Percival Aircraft, Ltd. *Luton, Bedfordshire*	P.74	.....	10	.....	.....	.....	4,900	8,000	1 Napier Oryx @ 750 ghp.	.....	.....	.....	.....	.....	.....	
Saunders-Roe, Ltd. *Osborne, E. Cowes* *Isle of Wight*	.....	Skeeter Mk. 5	2	32.0	31.1	7.5	1,570	2,100	1 Bl. Bombardier 702 @ 180 hp.	34	98	880	3,800	11,300	265	
	.....	Skeeter Mk. 6	2	32.0	31.0	10' 2"	1,626	2,150	1 DH Gipsy Major 200 @ 200 hp.	23	101	1,020	4,100	11,900	237	Training and liaison duties
Westland Aircraft, Ltd. *Yeovil, Somerset*	W-S-51	Dragonfly	4–5	49.0	.....	13.0	4,235	5,700	1 Al. Leonides @ 525 hp.	70	.....	750	.....	.....	220	Built under Sikorsky license
	W-S-55	.....	10–12	53.0	62.3	13.1	4,780	6,890	1 P&W R1340-40 @ 600 hp.	150	111	880	6,000	.....	430	Built under Sikorsky license
FRANCE																
Societe Matra *Boulogne-sur-Seine*	M.C.101	Cantinieau	2–3	25.3	22.0	7.5	882	1,325	1 Continental @ 135 hp.	.....	.....	.....	.....	.....	.....	
Societe Nationale de Constructions Aeronautiques du Sud-Est *Paris*	S.E.3120	Alouette	2	38.3	34.6	9.6	1,650	2,750	1 Salmson 9NH @ 200 hp.	32	78	885	.....	.....	.....	
	S.E.3130	Alouette II	5	33.5	31.8	9.0	1,810	3,300	1 Turbomeca Artouste II @ 400 hp	152	106	880	3,300	9,500	346	
Societe Nationale de Constructions Aeronautiques du Sud-Ouest *Paris*	S.O.1110	Ariel 3	3	35.4	24.6	.....	1,496	2,750	1 Turbomeca @ 275 eshp.	.....	102	.....	5,900	.....	155	
	S.O.1221	Djinn	2	32.8	17.4	9.6	682	1,540	1 Turb. Palouste @ 528 eshp.	.....	82	.....	3,280	.....	310	
	S.O.1310	Farfadet	4	36.7	.....	.....	.....	.....	1 Turb. Artouste 2 @ 360 eshp.	.....	150	.....	.....	.....	240	

Abbreviations:
Al. — Alvis
A.O.P. — Air Observation Post
Bl. — Blackburn
DH — De Havilland
MoS — Ministry of Supply
P&W — Pratt & Whitney Aircraft
Turb — Turbomeca

FAIREY JET-GYRODYNE

CLIFTON PRECISION'S NEW 8 SIZE SYNCHROS

Available in all Types!

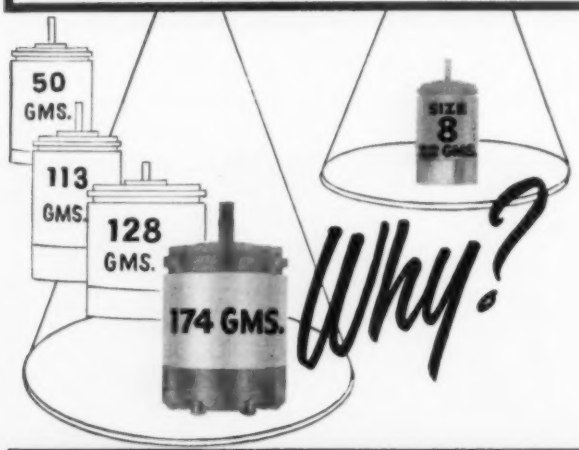
ACCURACY 7 MINUTES · WEIGHT 32 GMS.

Function	Type Number	Primary Element	Excitation Voltage 400 cy.	Input Current (ma.)	Input Power (Watts)	Primary Impedance Secondary Open (Phase)	Primary Resistance (Ohms)	Secondary Element	Output Voltage	Secondary Impedance Primary Open (Phase)	Secondary Impedance Primary Shorted	Secondary Resistance (Ohms)	Phase Shift Degrees	Sensitivity mv./deg.	Accuracy Minutes Max.
Transmitter	CGC-8-A-7	Rotor 1 Phase	26.0	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8.0	200	7
Control Transformer	CTC-8-A-1	Stator 3 Phase	11.8	90	.23	28+ j110	24.7	Rotor 1 Phase	23.6	220+ j740	246+ j60	143	8.5	400	7
Control Transformer	CTC-8-A-4	Stator 3 Phase	11.8	37	.09	67+ j270	59.5	Rotor 1 Phase	24.0	508+ j1680	640+ j190	381	9.2	400	7
Resolver	CSC-8-A-1	Stator 2 Phase	11.8	84	.27	38+ j136	27.0	Rotor 2 Phase	23.2	280+ j600	344+ j75	230	11	400	7
		Rotor 2 Phase	26.0	39	.43	280+ j600	230	Stator 2 Phase	10.6	38+ j136	70+ j29	27.0	20	180	7
Repeater	CRC-8-A-1	Rotor 1 Phase	26.0	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8.0	200	30*
Differential	CDC-8-A-1	Stator 3 Phase	11.8	85	.21	27+ j120	25.0	Rotor 3 Phase	11.8	38+ j122	47+ j14	36.0	9.0	200	7 Rotor 7 Stator

Total Null max. 30mv for each unit

*Torque 2400 mg.-mm./degree from CGC-8-A-7

Also available in 115v 400cy primary, 90v secondary Transmitters, C.T.'s, Receivers



WHY USE 1945 SYNCHROS IN 1956 DESIGNS?

Clifton's new Size 8's can take the place of larger units at very significant saving in bulk and *weight*.

These new Size 8's are now in use in some of the latest and *lightest* avionic equipment. In equipment which must be flown, why load on extra weight?

Samples are available from stock, quantities from the production line.

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I.R.E. Convention, New York City, March 19-22

LOOK TO CPPC FOR cppc *SYNCHRO PROGRESS*

CLIFTON PRECISION PRODUCTS COMPANY, INC.

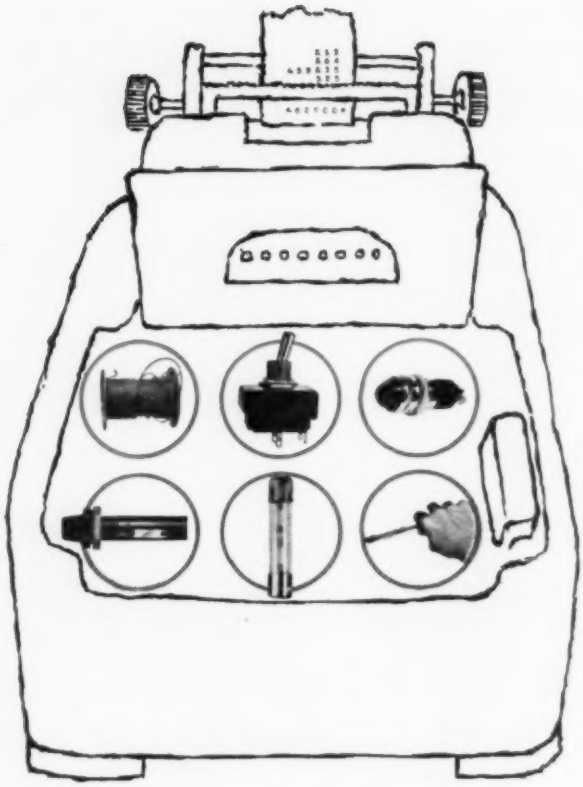
CLIFTON HEIGHTS PENNSYLVANIA

Leading Foreign Gas Turbines

Manufacturer and address	Designation	Type	Stages of compression	Turbine stages	Combustion chambers	Max. rating	Specific fuel cons., lb./lb./hr. or lb./eshp./hr.	Compression ratio	Overall envelope length, in.	Overall envelope diameter, in.	Dry weight, less tailpipe, lb.	Remarks
CANADA												
Orenda Engines, Ltd. *Malton, Ont.*	Orenda 10	AFJ	10	1	6	6,355 lb. t.	1.12	5.3	123	42	2,515	
	Orenda 11	AFJ	10	2	6	7,000 lb. t.	.....	.....	121	45	2,405	
	Orenda 14	AFJ	10	2	6	7,275 lb. t.	.....	.....	121	45	2,425	
	Orenda PS-13	AFJ	.....	.....	.....	20,000 lb. t.	.....	.....	.....	.....	.....	30,000 lb. t. w/afterburner
GREAT BRITAIN												
Armstrong Siddeley Motors, Ltd. *Parkside, Coventry*	Mamba ASM.6	AFP	.....	.....	A	.....	.....	.....	.....	.....	.....	Current production
	Double Mamba ASMD.3	AFP	.....	.....	A	3,035 eshp.	.75	.....	101"	52.8 x42.25	2,200	Current production
	Double Mamba ASMD.8	AFP	.....	.....	A	.....	.....	.....	.....	.....	.....	
	Sapphire Sa.6	AFJ	13	2	A	8,000 lb. t.	.90	.....	134"	37.4	2,700	Current production. Made under license in U. S. by Wright as J65
	Sapphire Sa.7	AFJ	13	2	A	11,000 lb. t.	.885	.....	132	37.4	3,050	Current production
	Sapphire Sa.12	AFJ	13	2	A	8,500 lb. t.	.900	.....	134	37.4	2,783	Uprated Sa.6
	Sapphire Sa.5	AFJ	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	Sapphire Sa.8	AFJ	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	Sapphire Sa.9	AFJ	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	Viper ASV.3	AFJ	7	1	A	1,640 lb. t.	1.09	.....	65.4	25	380	Life now 60 hours
	Viper ASV.5	AFJ	7	1	A	1,640 lb. t.	1.09	.....	65.4	28	515	
	Viper ASV.8	AFJ	7	1	A	1,750 lb. t.	1.1	.....	65.4	28	515	Current production. Uprated V.5
	Viper ASV.10	AFJ	7	1	A	2,000 lb. t.	1.01	.....	.....	28	570	Increased mass flow
Bristol Aero-Engines, Ltd. *Filton, Bristol*	Proteus 755	ACFP	12A, 1C	4	8	4,120 eshp.	0.445	7.2	100	40	2,850	
	Olympus 101	AFJ	.....	.....	10	11,000 lb. t.	0.77	.....	128	40	3,650	Under license in U. S. by Wright as J67
	Olympus 102	AFJ	.....	.....	10	12,000 lb. t.	.....	.....	132	40	.....	
	Orpheus 6	AFJ	.....	.....	.....	.....	.....	.....	.....	.....	850	Medium-power for lightweight fighters and trainers
	B.E.25	AFP	7A, 5A	4	10	5,050 eshp.	0.38	10.0	110	42	3,050	Supercharged turboprop
De Havilland Engine Co., Ltd. *Edgware, Middlesex*	Goblin 35	CFJ	1	1	16	3,500 lb. t.	1.16	3.7	101	50	1,630	
	Ghost Mk. 103	CFJ	1	1	10	4,850 lb. t.	1.16	4.5	121	53	2,154	Latest version is Mk. 104
	Gyron	AFJ	.....	.....	.....	15,000 lb. t.	.....	.....	154	46	.....	
	Gyron Junior 1	AFJ	.....	.....	.....	8,000 lb. t.	.....	.....	.....	.....	1,500	Scaled-down Gyron; est. data
D. Napier & Son, Ltd. *London W.3*	Eland N.E1.1	AFP	10	3	6	3,000 eshp.	0.62	7.0	120	36	1,575	
	N.E1.6	AFP	10	3	6	3,500 eshp.	0.56	7.0	120	36	1,575	
	N.E1.4	AFP	10	3	6	4,000 eshp.	0.56	7.0	122	36	1,800	
	N.E1.5	AFP	10	3	6	4,200 eshp.	0.56	8.0	122	36	1,800	
	N.E1.3	AFP & G	10+9	3	6	3,000 eshp.	0.62	7.0	166	36	2,350	Eland plus auxiliary compressor for helicopter application
	Oryx N.Or.1	AFG	12+4	2	5	750 ghp.	0.68	4.5 6.0	83	19	495	Gas generators for helicopter applications
	N.Or.4	AFG	12+4	2	5	825 ghp.	0.66	1.8 6.0	83	19	495	
	N.Or.5	AFG	12+4	2	5	950 ghp.	0.62	1.8 6.1	83	19	515	
	Gazelle N.Ga.1	AFP	.....	.....	.....	1,260 shp.	.....	1.9	.....	.....	.....	Free turbine engine for helicopter application
Rolls-Royce, Ltd. *Derby*	Dart Mk. 506	CFP	2	2	7	1,540 eshp.	0.73	5.5	95	38	1,044	
	Dart Mk. 510	CFP	2	2	7	1,740 eshp.	0.69	5.5	97	38	1,107	
	Dart R.Da. 7	.....	.....	.....	.....	1,890 eshp.	0.70	.....	.....	.....	.....	
	Dart R.Da. 7/1	.....	.....	.....	.....	1,990 eshp.	0.68	.....	.....	.....	.....	
	Dart R.Da. 7/2	.....	.....	3	.....	2,105 eshp.	0.665	5.75	91	38	1,201	
	Dart R.Da. 8	.....	.....	.....	.....	2,500 eshp.	.....	.....	.....	.....	.....	
	Derwent Mk 8	CFJ	1	1	9	3,600 lb. t.	1.05	4.0	83	43	1,280	
	Nene 10	CFJ	1	1	9	5,100 lb. t.	1.06	4.5	105	50	1,620	
	Nene 101	CFJ	1	1	9	5,000 lb. t.	1.09	4.5	78	50	1,618	
	Nene 102	CFJ	1	1	9	5,100 lb. t.	1.06	4.4	97	50	1,620	
	Avon 503 (R.A.25)	AFJ	12	2	8	7,000 lb. t.	0.91	6.1	103	42	2,440	
	Avon Mk. 42	AFJ	.....	.....	A	10,000 lb. t.	0.86	.....	113	42	2,790	
	Avon R.A.7	AFJ	12	2	8	7,500 lb. t.	0.92	6.5	110	42	2,460	
	Avon R.A.7R	AFJ	12	2	8	9,500 lb. t.	.....	6.5	120	42	2,485	
	Avon R.A.14	AFJ	.....	.....	A	9,500 lb. t.	0.84	.....	113	42	2,860	
	Avon R.A.21	AFJ	12	2	8	8,000 lb. t.	0.93	6.4	110	42	2,520	
	Avon R.A.28	AFJ	.....	.....	A	10,000 lb. t.	0.86	.....	113	42	2,900	
	Soar Mk. 101	AFJ	.....	.....	A	1,810 lb. t.	1.26	.....	77	16	275	
	Conway	AFJ	.....	.....	.....	13,000 lb. t.	.....	.....	.....	.....	.....	Bypass turbojet
	Tyne R.Ty.1	AFP	.....	.....	.....	4,470 eshp.	0.51	12	101	45	1,935	
FRANCE												
Societe d Exploitation des Materiels Hispano-Suiza *Bois Colombes (Seine)*	Nene	CFJ	1	1	9	5,066 lb. t.	1.04	4.0	93	48	1,608	Built under Rolls-Royce license
	Tay T250	CFJ	.....	.....	9	6,380 lb. t.	1.06	.....	100	50	2,022	Built under Rolls-Royce license
	Verdon R-450	CFJ	1	1	.....	7,700 lb. t.	.....	.....	101	49	2,015	Development of R-R Tay
Societe Rateau *La Courneuve (Seine)*	SRA-101	AFJ	10	2	12	8,800 lb. t.	0.85	.....	138	44	2,288	
Societe Nationale d Etude et de Construction de Moteurs d Aviation *Paris*	Atar 101D	AFJ	7	1	A	6,600 lb. t.	1.03	4.5	141	36	1,895	
	Atar 101E	AFJ	8	1	A	7,715 lb. t.	0.99	4.8	162	36	1,851	
	Atar 101G	AFJ	8	1	A	9,700 lb. t.	1.85	4.8	255	36	2,735	Afterburner mod. of E
	Atar 8	.....	.....	.....	.....	9,260 lb. t.	.....	.....	.....	.....	.....	
	Vesta	.....	.....	.....	.....	3,086 lb. t.	.....	.....	.....	.....	.....	
Societe Turbomeca *Paris*	Palas 2	CFJ	1	1	.....	352 lb. t.	1.15	3.9	47	16	158	
	Marbore 2	CFJ	1	1	.....	880 lb. t.	1.15	3.9	61	22	309	
	Gourdon	ACFJ	2	1	.....	1,430 lb. t.	1.05	.....	74	22	386	
	Gabizo	ACFJ	2	1	.....	2,400 lb. t.	1.04	.....	111	26	520	
	Soulor	ACFJ	2	2	.....	730 lb. t.	0.80	.....	59	18	.....	
	Artouste 1	CFP	1	2	.....	280 eshp.	1.00	3.7	36	16	215	
	Artouste 2	CFP	1	2	.....	400 eshp.	0.96	3.7	41	16	242	
	Artouste 3	ACFP	2	2	.....	600 eshp.	0.73	5.0	55	16	331	
	Marcadau	CFP	1	2	.....	400 eshp.	.....	3.7	54	16	309	
	Bastan	ACFP	2	2	.....	650 eshp.	0.72	.....	78	21	.....	
	Palouste 4	CFP	1	2	.....	.....	.....	3.7	45	19	198	Gas generator
	Autan	ACFP	2	2	.....	.....	.....	5.0	53	16	220	Gas generator
	Turmo 1	CFP	1	2	.....	270 eshp.	1.00	3.7	45	21	550	
	Turmo 2	CFP	1	2	.....	400 eshp.	1.04	3.9	48	16	320	
ITALY												
FIAT-SMA *Turin*	4002	.....	1	1	12	550 lb. t.	1.25	4.0	41	22	220	

Abbreviations

A — annular
ACFJ — axial-centrifugal turbojet
ACFP — axial-centrifugal turboprop
AFJ — axial-flow turbojet
AFG — axial-flow gas generator
AFP — axial-flow turboprop
CFJ — centrifugal-flow turbojet
CFP — centrifugal-flow turboprop
eshp. — equivalent shaft horsepower
ghp. — gas horsepower
lb. t. — pounds of thrust



does a fuse really cost less . . . than a circuit breaker?

Make a *real* cost comparison. Add up the cost of the fuse, fuse holder, power switch, wire; possibly a pilot light . . . and add in the labor. A circuit breaker usually eliminates all this equipment plus the labor to install it.

Then add your service expenses . . . when a blown fuse is replaced by a fuse of the wrong rating.

Total your figures . . . you'll find that the cost of a complete fuse installation parallels that of a circuit breaker. But in terms of superior protection for your product—and your reputation—you'll find a *final cost* advantage in the circuit breaker.

A Heinemann circuit breaker makes the *right* current rating an integral part of your equipment. What's more, you get Heinemann's dependable hydraulic-magnetic operation . . . with incredibly fast short circuit interruption, and a current rating that's never affected by ambient temperature.

If you're interested in cutting costs, send for a copy of the HEINEMANN CIRCUIT BREAKER ENGINEERING GUIDE, Bulletin 201.

Heinemann Type AM Circuit Breaker is available in odd or fractional ratings, instantaneous trip or a selection of time-delay characteristics.

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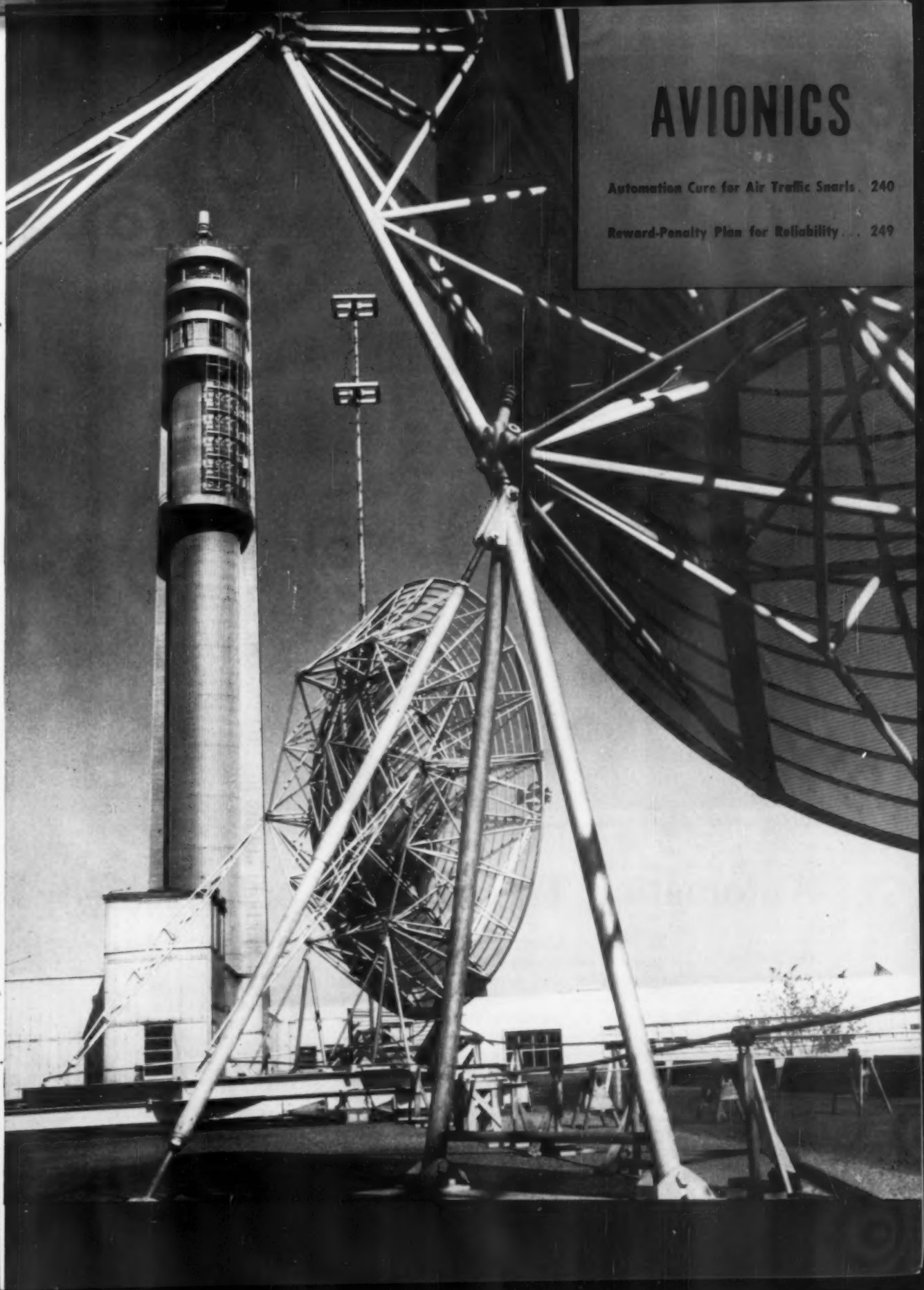
Circuit breakers

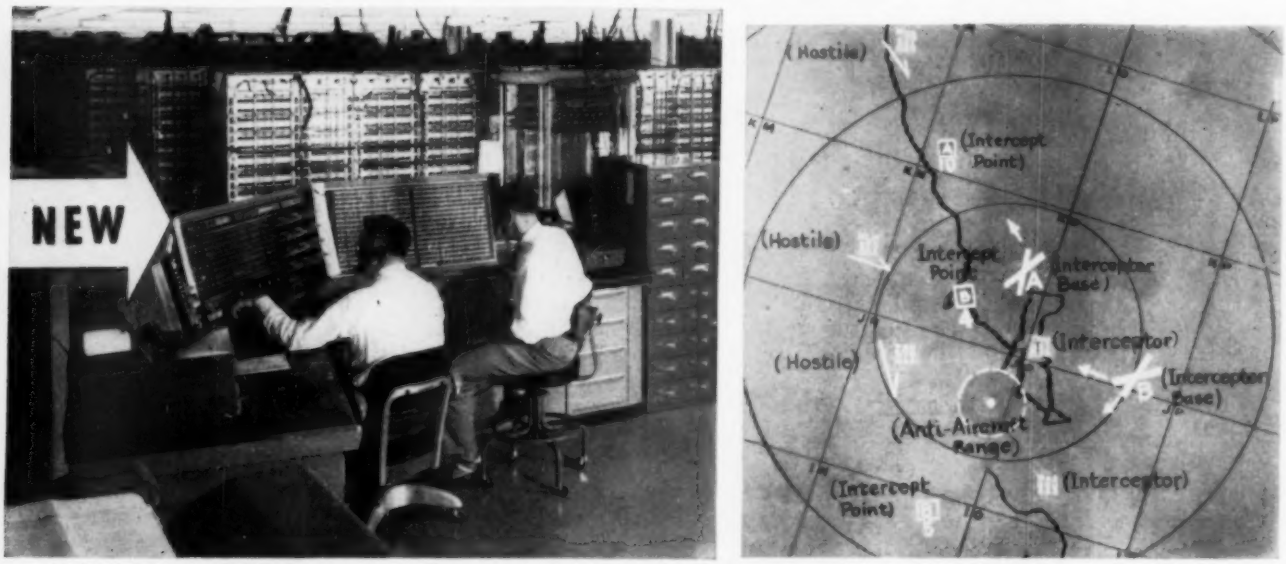


AVIONICS

Automation Cure for Air Traffic Snarls . 240

Reward-Penalty Plan for Reliability . . . 249

OLD MILITARY AIR DEFENSE SET-UP used human operators, voice communications and manual target plotting techniques.



NEW MILITARY APPROACH, used in SAGE, automatically processes data in computers and displays it on special radar scopes.

Automation Techniques Could Remedy

By Philip J. Klass

The solution to the pressing, and sometimes depressing, air traffic control problem can be summed up in one word: Automation. The Common System urgently needs more automaticity in routine communications, in plotting and displaying the air traffic situation and in managing traffic flow.

The required automation techniques are no problem. They are available now. The real problem is to find a way to merge the variety of civil and military activities and know-how into a single integrated Common System effort and to get all parties concerned to agree on "how," "what form," and "when."

The introduction of automation techniques for transmitting, processing, and displaying traffic control data would do much to ease the problems of:

- **Overburdened traffic controllers.**
- **Overloaded radio** communications.
- **Poor airspace utilization.**

There is almost universal agreement among the experts, both military and civil, that present and future aircraft speeds, coupled with existing and anticipated traffic loads, demand the use of automation techniques. For example:

- **"We need to relieve human** controllers of routine functions wherever this can be done safely, and put them in machines, which are better than humans in relatively simple repetitive operations. . . ."—James L. Anast, Air Navigation Development Board.
- **"In a dynamic traffic system** there is a constantly changing requirement for basic communications and internal communications dispatching. Soon there will be a requirement for the distribution of this information to a number of control computers. The human voice

OLD CIVIL TRAFFIC CONTROL SET-UP uses manual posting on flight strips.

NEW CIVIL SYSTEM differs little, except for addition or surveillance radar.

Air Congestion Headaches

does not lend itself to this type of operation so that automatic means of transmitting, receiving, display, and computer insertion will be simultaneously required. . . ."—H. I. Rothrock, special assistant to Head Air Navigational Aids Branch, Chief of Naval Operations, and chairman of the Air Coordinating Committee's Special Working Group 13 on navigation aids.

• **"To get an order of magnitude** improvement in capacity, air traffic control probably ought to . . . place more reliance on automatic aids. The number of operations to be performed and the time in which they must be accomplished are beyond the limits of reasonably human endeavor. . . ."—Kenneth G. Van Wynen and Charles I. Stanton, Bell Telephone Labs, in a paper delivered before the recent Institute of the Aeronautical Sciences convention.

Techniques Available

When Special Committee No. 31 (SC-31) of the Radio Technical Commission for Aeronautics met in 1947-48 to blueprint the future Common System, many of the automatic equipments and/or techniques needed to implement their "Ultimate System" were merely gleams in some designer's eye. At least a few of the "blue sky" ideas proposed at that time were considered to be beyond the nation's pocketbook, if not beyond technological realization.

Today, thanks to Soviet policies and U. S. avionic industry ingenuity, many of the "blue sky" ideas of 1947-48 are operating realities, or nearing that stage, in the military services.

For example, SC-31 rejected the idea of a Common System based on a vast network of ground radars, because of the tremendous initial cost and upkeep. Today, for air defense purposes, we have a growing network of ground radars which eventually will surpass the fondest hopes of the ground-radar proponents in SC-31.

These radars are being spun into a web of automatic data processing machines, called SAGE, which will automatically keep tab on all aircraft, and display aircraft position, altitude, identity, speed and other data on large cathode ray tubes in symbolic and pictorial form (AW Jan. 30, p. 46).

The SC-31 concept of a "private line," for speedy transmission (by code, with automatic decoding) of routine instructions from ground to air and air to ground, is now coming into military use, where it is called "data link." Several of the more sophisticated military data link systems also provide for automatic control of aircraft from the ground.

Air traffic control transponder beacons, and the associated "secondary radar" on the ground which interrogates them to provide automatic identification of each aircraft blip on a radar scope, were a cornerstone of SC-31's Ultimate System. Today they are in military use and in early prospect for civil aircraft.

Too Many Cooks

Irony of the present situation is that we do not lack for the necessary techniques or ideas to automate the present ATC problem out of existence. The problem is that we have too many possible solutions. For example, while the proponents of civil DME are doing battle with those of the newer military Tacan navigation system, several authoritative voices have been raised to suggest that the new Air Defense SAGE system could be modified to provide an even better rho-theta navigation system.

There are too many "cooks," each with one or more pet "recipes," trying to please a variety of gourmets, each with a different idea as to what the meal should include and how much it should cost.

In most cases, this is no mere obstructionism on the part of individual airspace users. Each has his own problems, some of them unique. However, within the past year there has been a noticeable tendency on the part of two major airspace users, the military and the air

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carriers, to recognize that the increasingly congested airspace and radio spectrum is a mutual problem, requiring a Common System solution.

For example, Rothrock, in discussing the Navy's problems, told the IAS that "the Navy cannot solve its problems in a vacuum. It cannot demand that its requirements be fulfilled without being willing to grant equal rights to the other users of the airspace.

"We need a truly Common System, in the broadest meaning of the term," Rothrock said, "but we will never have it so long as any operating or service organization spends its time in an attempt to achieve its own ends regardless of the results."

Considering that it was the Navy's development of Tacan, out of Common System wedlock and under security wraps, originally for tactical use, which precipitated the present bitter Tacan-DME controversy, Rothrock's statement is a hopeful sign.

It is evidence that the military have learned a Common System lesson from Tacan. Unless Tacan is adopted as the Common System aid, military aircraft will either have to carry 250 lb. and $10,000 worth of extra (civil) navigation equipment, or else be designed to permit speedy conversion from civil to tactical equipment as their assignment requires.

Hopeful Sign

Backing up his call for joint military-civil attack on current problems, Rothrock said "there is an urgent requirement for the establishment of a group to study the future requirements for military and civil automatic communications from a systems as well as an equipment standpoint."

Rothrock's statement is quite significant. Civil aviation has long talked about a civil "private line," or Air Traffic Control Signaling System (ATCSS), as it is now called, as a means of speeding air-to-ground and ground-to-air communications and relieving overcrowded radio channels. However, it was known that the military were spending considerable money to develop similar data link systems for tactical use.

Civil aviation people have not wanted to duplicate military efforts in this field and have been waiting hopefully for the security wraps to be lifted. Rothrock's statement indicates that the military may now be ready to at least share their data link techniques, if not their tactical system, with civil aviation.

Automatic Data Transmission

Bell Telephone Lab studies reveal that a major cause of traffic control problems and delays is the excessive time which controllers must spend in communications chores (AW Feb. 13, p. 65). Hence, automatic transmission of routine flight and traffic control data by means of data link holds promise of a big pay-off. For example:

• **Speed communications.** To transmit a routine message, such as "hold at the fan marker," or "descend to next lower altitude level," a traffic controller would need only to push two buttons: one to address the message to the proper aircraft, and the second to send the desired message.

• **Less chance for error.** With data link, the message can be displayed in the cockpit on a cathode ray tube, or other visual indicator, reducing the chance for error or misinterpretation.

• **Reduce radio spectrum congestion.** Because messages are sent in coded form, their transmission time is far less than for voice communications, making more efficient use of overcrowded spectrum. Voice communications still would be used for special situations and instructions.

More gain can be realized if automatic data transmission is used for air-to-ground communications. Instead of aircraft position, altitude, speed, and other information being transmitted by voice, then manually recorded on flight strips or otherwise introduced into the traffic situation display, this can be done automatically, with existing technique and/or systems.

For instance, the Tacan system, in addition to giving the pilot his bearing and distance, also provides a two-way data link system, as first revealed by AVIATION WEEK (Nov. 21, 1955, p. 61). Tacan data link system not only enables the ground controller to transmit a limited number of commands to the aircraft, but reportedly enables the aircraft to automatically reply, giving its bearing, distance, altitude, and speed.

Another possibility, for automatic aircraft position reporting, is to use the ATC transponder, provided sufficient codes can be made available to the civil aviation transponder.

Equally important is the application of automatic data transmission between traffic controllers, both within a single Air Route Traffic Control Center, and between different ARTC centers. At present, this information must be transferred by voice. This involves reading off data from one flight strip and the preparation of a new one, both possible sources of error.

Next, Automatic Data Processing

There are two logical reasons for going to automatic data processing machines for scheduling traffic flow and approach, once automatic coded communications come into use:

• **Saturation of human controller.** As the number and speed of aircraft increase, and the airspace is used in greater depth (above 30,000 ft.), the number of variables which an individual controller

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must weigh in arriving at a control decision exceeds human capabilities.

• **Avoids conversion delays.** Once the information is in coded form, it is time-consuming and awkward to convert into form suitable for human use, then reconvert back into coded form for transmission to interested parties.

These are some of the same considerations which led to the present semi-automatic SAGE system for air defense, with its automatic data processing techniques.

"The role of the human controller through the next two decades will gradually reduce to a 24-hour standby operator for a lower-capacity system in the event of mechanical or electrical failures," is the way ANDB's Anast sees it.

Rothrock says the future Common System "will need traffic control computers with the capability of accepting vital position, velocity and destination information on all aircraft in a given area, automatically computing optimum safe tracks, and providing the pilots with the guidance required. . . ."

Forerunner of the type of computer which Anast and Rothrock envision is the Air Force-developed Volscan traffic manager (AW Dec. 28, 1953, p. 38). The original Volscan computer, and new production prototypes being readied for test, automatically computes a non-conflicting time-of-arrival for each aircraft entering the area, then calculates what flight path the aircraft must fly to bring it to the approach gate at the proper time.

However, traffic control computers designed for Common System use will require considerably more sophistication and complexity than Volscan, which was designed primarily as a military return-to-base computer.

Automatic Display Need

To round out the automatic techniques for obtaining and handling traffic control information, greatly improved methods are needed to display the traffic situation. Preferably the display should be an instantaneous automatic or semi-automatic type. Cathode ray tubes are only a partial answer because they are two-dimensional devices attempting to show a three-dimensional situation.

Special tubes like the Convair Charactron, which can also display symbols to show each aircraft's altitude, speed, and other information, are a partial answer, and are being employed in the air defense SAGE system.

Projection systems for displaying radar scope presentations, or large horizontal radar scope displays, where small markers ("shrimp boats") with suitable aircraft identification information can be manually superimposed on the radar blip, are an improvement over the long-used flight posting strips. However, this display technique is limited to those areas that have radar coverage, which is a small portion of the nation's airways.

When you put the jigsaw pieces of the future together, the result bears a striking similarity to the present SAGE system, which explains why its possible use for the Common System has been suggested in several quarters.

SAGE No Easy Solution

There is no question but that the information which will be piped into the SAGE system from its network of ground radar stations is the same kind of data needed for traffic control.

However, in its present form there are two hurdles to SAGE's use for Common System traffic control:

• **System capacity** was not designed with that task in mind.

• **System design** was intended to bring interceptors into contact with enemy aircraft, not to keep aircraft separated, which is fundamental to traffic control.

So far, Lincoln Laboratory, which developed the SAGE system, has not been asked to adapt it to air traffic control, Dr. George E. Valley, Jr., associate director of the lab told the Jet Age Conference (AW Feb. 13, p. 108). This may follow if ANDB-sponsored feasibility investigations in the Boston area prove out.

The Navigation Lab of the Air Force Cambridge Research Center, located at Deer Island, near Boston, together with the Civil Aeronautics Administration, plan to run tests and studies this year to determine the feasibility of utilizing air defense facilities for Common System use.

ANDB's Anast optimistically says that he "expects these tests will result eventually in a fairly complete physical integration of air traffic control and air defense facilities (with) great savings in personnel and communications facilities."

However, Common System users cannot sit back, confident that SAGE is a cure-all. Integration of a long-established civil system, used by a variety of aircraft operators, some with limited pocketbooks, with a complex, radically new and unproven system such as SAGE will not be easy.

Furthermore, with the prospect of intercontinental ballistic missiles, the air defense problem has become far more difficult to solve than when SAGE was first conceived. Hence Lincoln Lab can be expected to devote all of its efforts to upgrading SAGE's capabilities to meet this new threat. Where it proves necessary to compromise either SAGE performance or Common System requirements, the latter naturally will have to give.

The SAGE program, in its concept and execution, has a very pointed lesson for those responsible for the develop-

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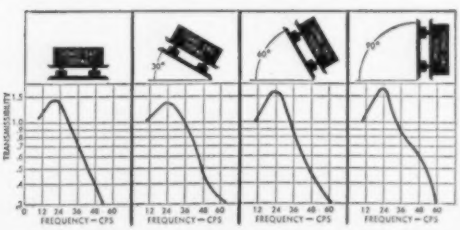

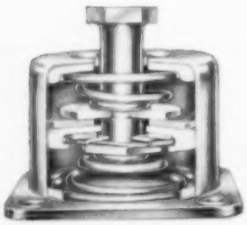

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ment of the future Common System. Early air defense planners had the vision to recognize the magnitude of the problem, and that it could only be solved by using the "systems engineering approach."

The SAGE program is testimony that successful application of the systems engineering philosophy requires a competent systems engineering group and a working laboratory where new developments can be evaluated with other segments of the system. This is the only way to solve such complex problems as air defense and air traffic control.

Pooling of Effort Needed

There are many persons, particularly within the ANDB, who recognize this need. ANDB has hopes that the Air Force Deer Island facility may grow into such a Common System proving ground.

At present, however, it is undermanned and lacks facilities for such an assignment.

The cost of providing the facilities and manpower necessary to evaluate the complex systems required to solve our traffic control problems will not be low. Yet it will be cheap in comparison to the economic loss which the nation will suffer in poor utilization of its civil and military aircraft if such facilities are not provided.

Because of the time required to assemble facilities and manpower after funds are made available, there is much need for haste.

If Deer Island does become a Common System laboratory and proving ground, it will be a significant start on a long-range solution to the present problems. However, there will still be a basic shortcoming in the set-up.

Although ANDB is responsible for sponsoring programs and developments for Common System use, the several million dollars which it has to spend annually is but a small fraction of the military money going in the development of similar techniques and equipments intended for tactical use.

Collectively the nation is pouring a great deal of scientific effort into communications, navigation, and traffic control developments. However, the results are not being collectively applied to Common System problems, partially because of military security.

If President Eisenhower's new Special Assistant for Aviation Facilities Planning, Edward P. Curtis, can find a way to harness the nation's collective know-how and efforts in this field, the problems of mushrooming traffic in the jet age can be solved, probably in time. Otherwise the growth of the nation's civil and military airpower will be badly throttled.

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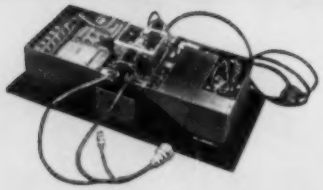

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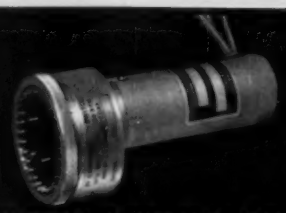

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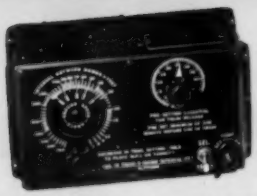

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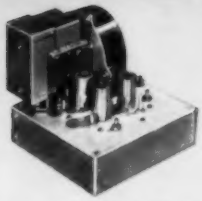

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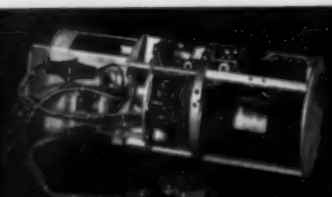

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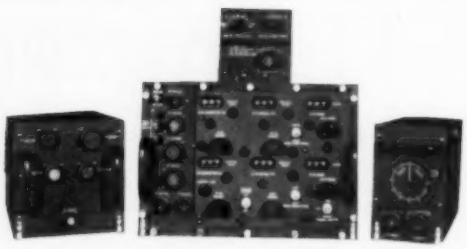

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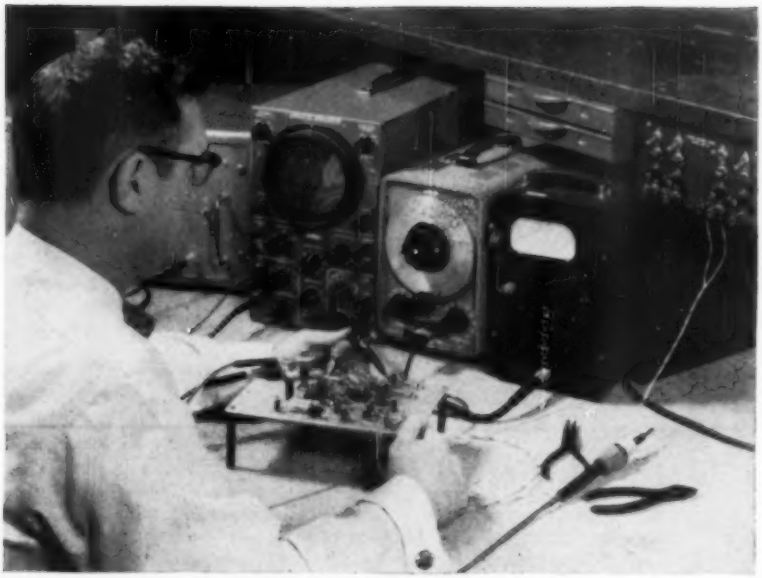

RELIABILITY BEGINS AT THE BREADBOARD

Military Penalty-Reward Plan Will Force Avionic Reliability Efforts

The Defense Department has launched a new program which may well revolutionize the procurement, development, design and manufacture of avionic equipment and its component parts.

The new program, which holds promise of getting at the root of avionic equipment unreliability problems, is aimed at easing the military maintenance burden and saving the taxpayer's money as well.

When the results of current Defense Dept.-industry studies are implemented, perhaps in another year, specifications for new equipment developments may include specific "minimum reliability figures" to which the equipment must be designed.

To put teeth into this provision, the contract may spell out detailed tests and reliability studies which must be run on the equipment at every stage of its life cycle—development model, pilot production model and production units.

In selecting contractors for both development and production, procurement regulations may be revised to require evaluation of the potential contractor's ability to produce reliable designs. And when production contracts are awarded on the basis of low-bid, the Defense Department may add estimated maintenance costs to the contractor's bid price to come up with an overall cost figure.

The need for such an approach is pointed up by a Rand Corp. study which showed that the Air Force spends about two dollars every year just to maintain each dollar's worth of airborne avionics equipment. Thus, about eight to 10 times the original equipment cost is spent in maintenance during its lifetime. With present procurement practices, what may seem to be a bargain in initial price can turn out to be a costly illusion.

Time for Action

Spearheading the Defense Department's electronics reliability program is J. M. Bridges, Director of Electronics, Office of the Assistant Secretary of Defense for Applications Engineering. Prior to taking his present post, Bridges was chief engineer of the New York Telephone Co., where reliability is not only a fetish, but an operating reality.

Bridges believes that the increased emphasis and attention focused on the reliability problem by various Government, technical and industry groups has had a salutary effect. "There is a definite indication that some of the new electronic devices, developed over over the past two or three years, are reflecting the broad and intensified emphasis on reliability," Bridges says.

"However, in spite of all the general educational and stimulating information that is published, discussed around the conference table, and spoken from the rostrum, important military electronic equipments are still coming out of our laboratories and going into production with design deficiencies that are almost certain to make the equipment unreliable," Bridges quickly adds.

Reliability Knowledge

Emphasizing that he does not suggest dropping the broad program of educating all concerned with the problems of reliability, Bridges believes however, that "we have come to a point where the productivity of the general educational approach is diminishing. We now need to become more specific in our actions if we are to obtain the degree of reliability improvement demanded for military electronic equipment.

"We know enough now about some of the basic causes of unreliability to permit specific unified action to be taken in certain areas by the military departments," Bridges says. For example, current controlled tests on Tacan receivers, now under way at the Navy's Johnsville, Pa., facility, have produced more useful data on basic causes of unreliability than could have been obtained in two years of actual in-service use, Bridges reports. Radio Corp. of America's program to debug the AN/ARC-21 transceiver also has added to the pool of reliability knowledge.

"We are also sufficiently aware of the effects of unreliability to know that more drastic measures are justified," Bridges warns.

To work out a program which is both

Like a Woman

"In supersonic nuclear warfare, electronics is like a woman—difficult to live with, impossible to get along without." This is the way one military spokesman sums up current thinking on electronics and its reliability problems.

The growing numbers and complexity of avionic equipments, with their maintenance and logistics problems which result from lack of suitable reliability, coupled with the difficulty of getting and keeping skilled technicians who can keep the equipment operating, are cause for major concern in the military services.

After several years of grappling with this elusive problem, the Defense Department has come up with an ambitious program which holds promise of coming to grips with the problem in its breeding grounds—the development labs, design engineering groups, and the "front offices" of the nation's electronics industry.

This article describes the program.

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Contractor Capability Important

"We must give far greater consideration to the demonstrated capability and desire of a contractor to do a good reliability engineering job before selecting him," according to J. M. Bridges, Director of Electronics, Office of the Assistant Secretary of Defense for Applications Engineering.

"Regardless of how thoroughly and completely we establish in specifications the parameters of reliability and the methods of meeting them, the quality of the resulting design depends very largely upon the competence, experience and management attitude of the contractor.

"We must make it clearly known throughout the electronics industry that the demonstration of a company's ability and earnest desire to do a thorough and excellent reliability engineering job is a firm prerequisite for obtaining continued military electronics development and engineering contracts.

"In selecting a contractor for a developmental program, price and promised time schedules should be secondary to the assurance that a contractor has the capability for delivering high-quality engineering."

realistic and reasonable, Bridges' office has formed nine industry-military working groups to study different facets of the problem and come up with specific implementation recommendations.

Each group is headed by an industry representative, and consists of two representatives from each of the three military services, as well as several more industry representatives. Collectively the nine new committees form the Advisory Group on Reliability of Electronics Equipment (AGREE).

Each of the nine AGREE committees has been given a specific assignment. Among them:

• **Develop minimum acceptability figures** for reliability of various types of military electronic equipment. These figures may be expressed as time-between-failure or on some other basis, providing it can be specified in a quantitative way.

The figures chosen for each type of equipment will reflect such factors as its operational mission requirements, maintenance, complexity, and/or other significant factors. For example, minimum acceptability figures for the reliability of a yaw damper system, whose failure incapacitates the aircraft, would be higher than the figure for a flight director system, whose failure would merely inconvenience the pilot.

• **Develop basic test requirements,** for use on development models, which will prove conclusively that the design is capable of meeting the minimum acceptability figure for reliability for that particular type of equipment. These tests would be in addition to the performance requirements set forth in the equipment specifications.

• **Develop basic test requirements** for use on pilot production and full production models, which will prove conclusively that the equipment meets acceptability figures.

• **Investigate and recommend methods** of specifying development procedures which will insure that equipment designs have the required reliability. This may include such things as theoretical reliability prediction, component selection, qualification and application for specific circuit and environment requirements.

• **Establish criteria and techniques** for specifying reliability of components and tubes in terms of failure rate as a function of time and environment. (Bridges believes that this is essential in order to determine how much improvement in components is needed to meet the reliability requirements of different types of equipment.)

As part of this phase, Bridges believes it is necessary to revise the procedure by which component manufacturers now obtain military approval of their new products. At present, qualification is granted on the basis of experimental samples, with no subsequent follow-up to assure that production units are produced to the same standards.

Bridges believes it may be desirable to run military qualification tests on pilot production components, and then require re-qualification every two years.

Procurement Scrutinized

The AGREE program includes:

• **Study of procurement and contracting** practices and regulations to determine their compatibility with reliability objectives. The committee is to recommend changes where desirable to improve reliability.

• **Investigate equipment packaging** practices for shipment, and recommend improvements which will enhance reliability.

• **Investigate equipment storage** and its effects on reliability, together with recommended improvements.

• **Review operational and maintenance** procedures and suggest improvements which would enable equipment performance to be maintained in services at, or near, its inherent design level. The committee will consider whether maintenance should be based on equip-

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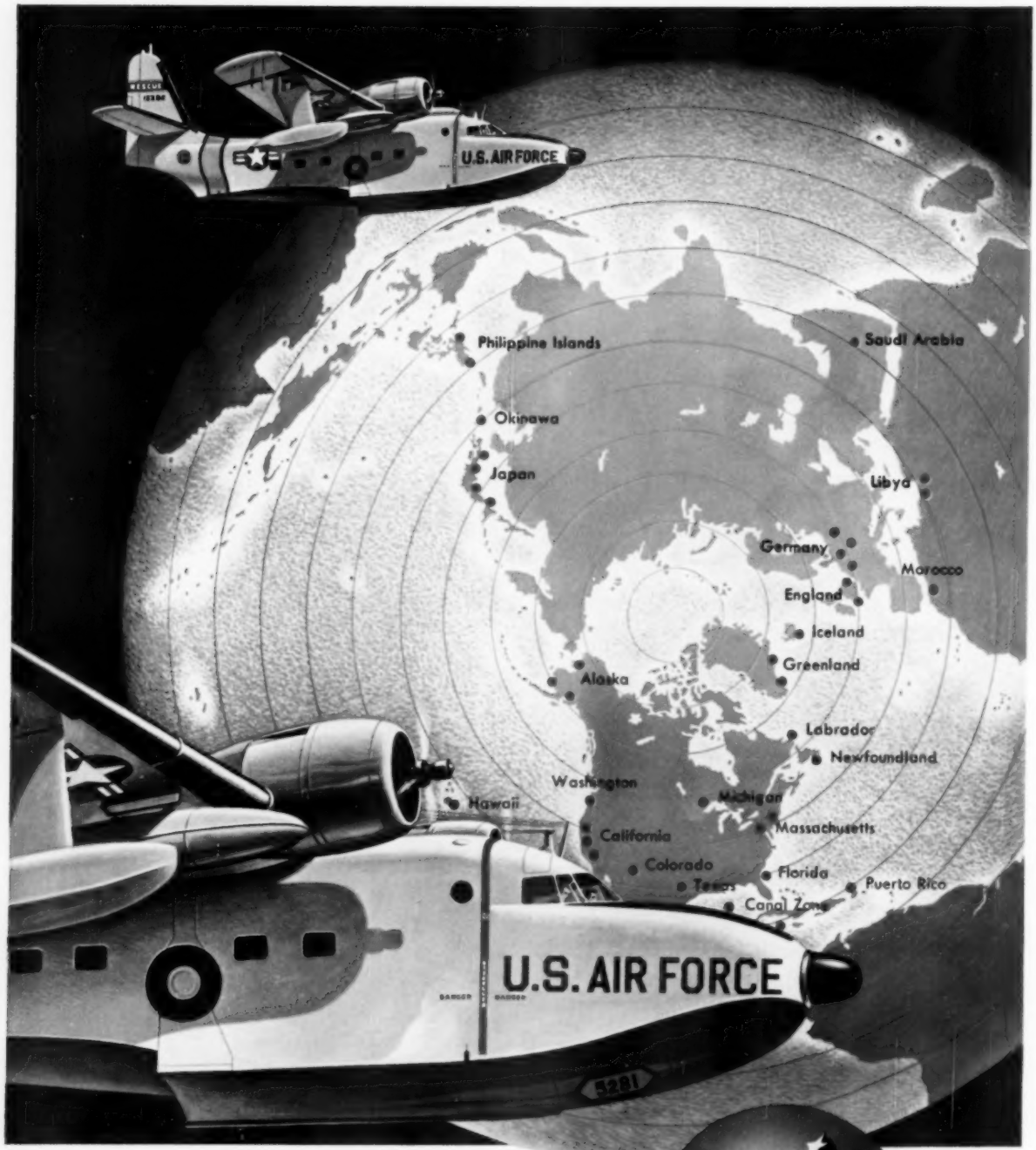

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ment performance, rather than being carried out at regular time intervals, use of marginal testing, and personnel training problems.

Procurement Policy Scope

In studying current procurement practices, and their effects on reliability, Bridges has asked the AGREE group to evaluate:

• **Implementation of Defense Directive No. 4105.10.** This directive issued Mar. 17, 1955, recognizes that in highly complex equipment it frequently is to the Government's advantage to place initial procurement with the company which developed the equipment. The directive says, in part, that where analysis indicates "it is in the Government's interest to award such production to a development contractor, price advantages alone should not be allowed to dictate an award elsewhere."

• **Methods of selecting contractors** for development and production, and the possibility of including an evaluation of their ability to produce reliable designs.

• **Possible advantages of combined** development-production contracts.

• **Possibility of adding estimated maintenance** costs to a bidder's quotation to come up with an overall price before determining the low bidder on a contract.

Cause of Unreliability

While some claim that the military must accept increasing unreliability as the price of more complex equipment required in modern warfare, Bridges' experience with the much more complex equipment used by the telephone companies leads him to other, and more optimistic, conclusions.

Despite the fact that components, including tubes, bear the brunt of criticism for present reliability problems, Bridges believes that the greatest cause is "the lack of maturity of product design and failure to evaluate the inherent reliability of design, through realistic engineering tests and service evaluation, before major production is undertaken."

Both the military and industry must share responsibility for this situation, Bridges believes. When an advanced new weapon or equipment has been developed, the military understandably is anxious to rush it into production to meet a pressing tactical need. The research and development engineers, in turn, concentrate on achieving the basic technological goal, and often neglect the laborious and less glamorous job of engineering the device for production and service use. Bridges says:

"The greater the technical achievement, and the correspondingly increased potential tactical usefulness, which together usually mean more complexity, the greater the urge to hasten production for service use."

Too often, both parties interpret a successful functional demonstration of an experimental model as indicating that it is ready for production, Bridges adds.

Such haste results in expensive and time-consuming design fixes on the production line, extensive field retrofit modification programs, and sometimes, the dropping of the entire program.

Sound Engineering Needed

The military must take positive action to be sure that every new item ordered into production has a solid foundation of reliability engineering during its development, and has proved its reliability through tests such as those which AGREE is now developing, Bridges believes.

While the quality of tubes and components plays a vital role in equipment reliability, and further improvement is desirable, Bridges says that the real reliability problem stems primarily from the way that these tubes and components are used in circuit and mechanical designs.

Unless an equipment has sound engineering during its development period, it is almost certain to prove unreliable, despite the highest quality tubes and components, Bridges says.

Reliability engineering should start during the development phase—not after it is completed. Unless the early breadboard circuits are designed to use tubes and components well within their established ratings, and to work properly when these components' characteristics vary over allowable limits, the resulting production equipments are likely to be in trouble.

Bridges urges more attention to packaging and mechanical design of electronics equipment during the development phase. This means bringing in qualified mechanical engineers to work alongside the circuit engineers.

Bridges believes that the development model of an equipment should be a good barometer of the potential reliability of the ultimate production equipment. This is the thinking behind AGREE's efforts to define reliability quantitatively and set up necessary correlation factors between the reliability of development models and the production items.

Longer Development Cycle

Bridges admits that the addition of reliability engineering will extend the development cycle and increase its final cost.

However, there will be an offsetting reduction in the time and cost required to make the transition from development model to production, he believes. "In fact, I would expect the overall

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time scale and cost, from the start of development to production, to be less," he says.

However, the major benefit which Defense seeks, and hopes to gain from the new plan, is a marked improvement in equipment reliability.

As proof that developmental models can be designed for reliability, Bridges cites the two following examples:

• **Shipboard radar,** employing 200 tubes, operated in Navy's Operational Development Force for 22 months with only two recorded failures. One of these was a transformer failure, while the other was due to foreign matter in the waveguide.

• **Airborne range-only radar,** was bench and flight tested for 18 months without a single failure.

Pilot Production a Must

Another major way to improve electronics equipment reliability, Bridges says, is to make it mandatory that pilot production and realistic service evaluation of the pilot-produced equipments precede large-scale production. By pilot production, Bridges means the controlled manufacture of a limited number of items to the same drawings, specs and with the same tooling, if possible, that will be used for full-scale production.

The objective is to verify the producibility of the design and provide sufficient numbers of production-type equipments to obtain statistical quantities of data from the service evaluation. Unless design shortcomings are discovered and corrected before full production gets underway, changes are difficult and costly to make.

Bridges believes that pilot production is part of the design engineering program, because it is the first real proof of the design. This leads him to say that pilot production should go to the original equipment developer, in line with Defense Direction 4105.10.

Now Is the Time

Bridges estimates that it will take at least a year for AGREE to thrash out its recommendations and work them into Government specs and procurement regulations. However, alert avionics manufacturers will not wait for lightning to strike.

Many firms are accustomed to "throwing together" a breadboard equipment merely to prove principles. While the new philosophy won't eliminate the breadboard circuit, it will mean that the equipment delivered to the Government will have to be a reliability engineered version of the breadboard.

An unreliable development model will seriously jeopardize the equipment's future, and the contractor's chance of getting a production order.

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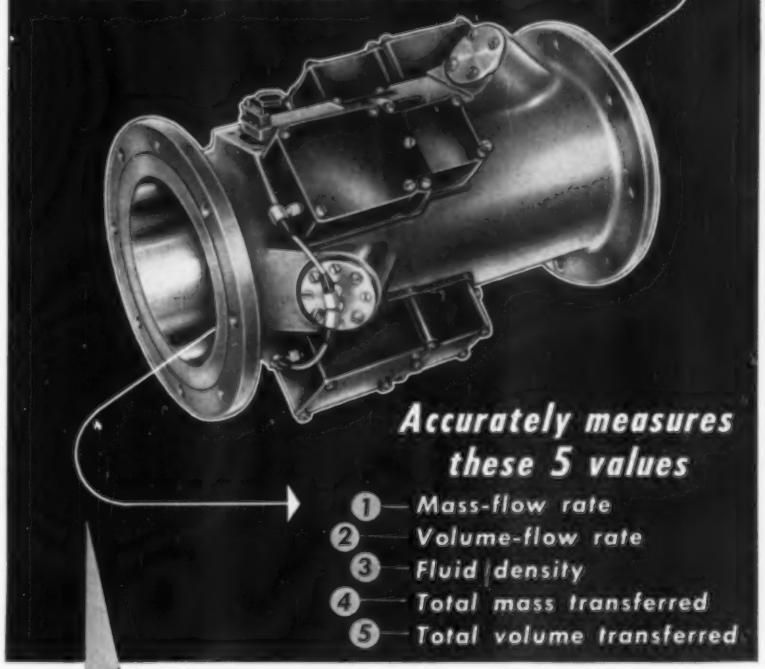

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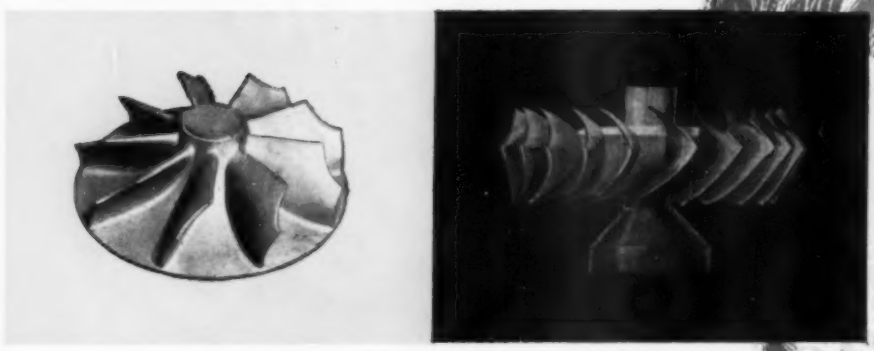

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HELICOPTERS

Helicopter Design Lags.....258

PIASECKI H-21

PIASECKI HUP-4 ON CANADIAN NAVY MISSION

Helicopter Design Lags Behind Needs

Enthusiasm for the potential of the helicopter, particularly among short-haul airlines, continued to be high in 1956.

Despite the fact that progress toward achieving this potential remains slow, studies of the market have lost none of their optimism. The big question is just the same as it was a year ago: Where is the equipment?

The answer also is a year old and still must come from the military services, who have had it from the beginning. They continue in their role as the helicopter industry's biggest customer, severest critic and sponsoring angel of the developments that will make the commercial potential pay off, if it does.

Nobody has mentioned it out loud, but there is apprehension in the industry over the Federal Government's proposed new highway program. From a current spending rate of $790 million a year for roads, the Administration proposes to climb to an annual outlay of $3.2 billion by 1965. Naturally, a substantial portion of this money will go into turnpike projects, roads which the builders know will be heavily traveled.

It has been estimated that today all the common carriers are getting no more than 12% of the traffic in the 60 to 250-mile trip range. This is the range being eyed so happily by short-haul airlines, with avid interest in rotary wings. Further, experts say, the percentage is going to decline. There is no doubt about it—the turnpike-building program is a major factor in this picture.

BELL XH-40

Those who are skeptical of the helicopter industry's ability to turn out large, comfortable, economical multi-engine aircraft by the target date of 1960 are predicting that more short-haul passengers will use autos. On top of this, the past year has seen the interest of major airlines centered on the introduction of turboprop and turbojet transports. These developments seem to have taken all of their attention.

The Rotorcraft Committee of the Air Transport Assn., for example, will meet later this month for the first time since February of 1955. High on the agenda will be the demand by some of its members that navigation and air traffic control systems for long-range and high-speed jets must be designed for use by helicopters as well as new fixed-wing transports.

Most Promising Copters

The meeting also will seek coordination of airline ideas on helicopter design, performance and heliport specifications. "A major necessity," one expert told AVIATION WEEK, "still re-

mains the same: a helicopter that can make money.

"The job can be done, but it is contingent on a supermarket approach to the operation, with lowest possible overhead for each passenger handled."

Best bets are the same as they were a year ago. These aircraft are the Sikorsky S-56, designed as a Marine assault helicopter, and the Piasecki YH-16, a transport similar in size to the DC-4. The S-56 has spent a year fighting mechanical difficulties while its designers have struggled to come up with worthwhile improvements. The second Piasecki YH-16, powered with T38 turbine engines, met disaster this winter. The program will be continued with support from the U. S. Army.

Meanwhile, most promising aircraft appears to be the Sikorsky S-58, known to the Army as the H-34 and to the Navy as the HSS. It is a single-engine helicopter and for this reason remains only an interim aircraft to commercial air line operators. New York Airways has ordered eight S-58s and Sabena, Belgian air line, has ordered seven. Both will start taking deliveries this year.

Praise For S-58

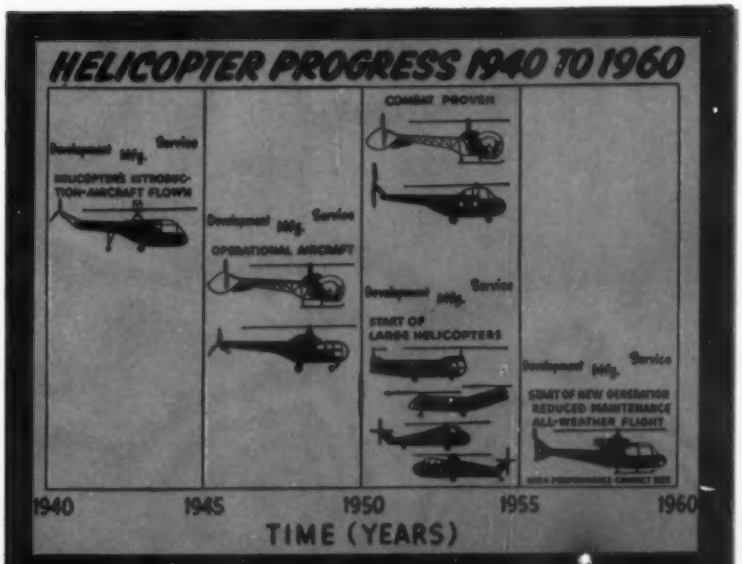
The S-58 will carry 12 passengers. There are glowing reports from the military services on its performance capabilities. The Navy, for example, says it is the first helicopter to meet all requirements for instrument flight.

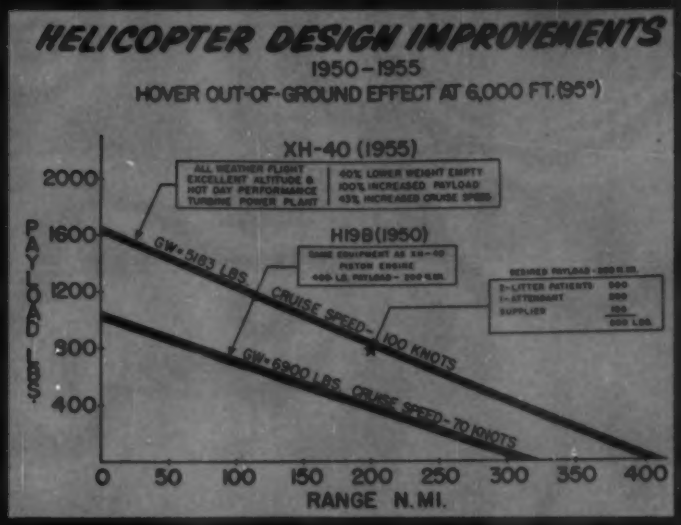
Success of the S-58 and its quick appeal to New York Airways and Sabena forced Piasecki Helicopter Corp., now changing its name to Vertol Aircraft Corp., to abandon plans for commercial certification of the H-21. Vertol can be expected to come back, however, with a turbine-powered version of this tandem, on which development work is going forward under Army sponsorship. Sikorsky also is working on a turbine engine S-58. Both helicopters will have more than one engine, providing greater safety and comfort.

The past year also has seen the slow death of a proposed joint Army-airlines venture to build up scheduled experience with present rotary-wing equipment. The general idea was that the military would provide some equipment for air carriers to use hauling mail and cargo over regular civil routes on a time-table basis. The operators have lost none of their enthusiasm for this project, but its military sponsors have failed to win necessary approval at the Pentagon.

A top Army aviation officer told Aviation Week his service still likes the idea but that Air Force cooperation is needed and is not forthcoming. "We can't do it by ourselves," he said.

There are a few other factors that indicate the commercial helicopter out-





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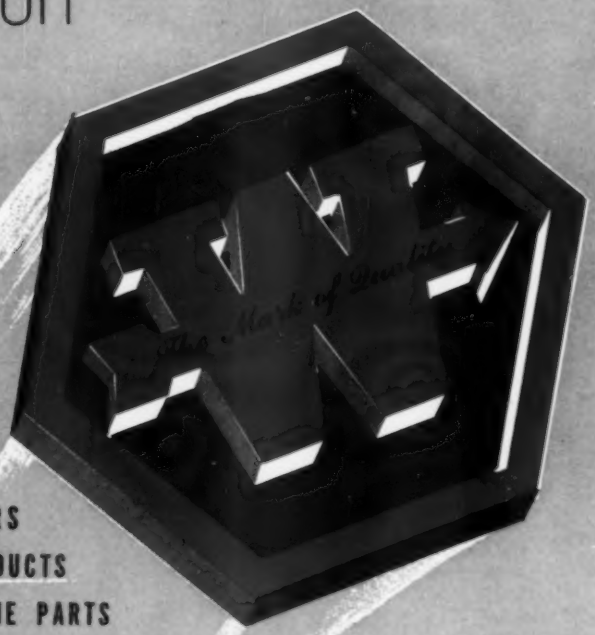

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● HELICOPTERS

look has been more or less stagnant for the past year. They include:

• **Maintenance and operating** costs still are high, although there have been notable advances in prolonging the life of critical components. The high costs are reflected in the amount of Civil Aeronautics Board subsidy given to the two existing helicopter passenger services in New York and Los Angeles, although indirect costs also are an important factor. The CAB subsidy per passenger carried in New York is $48.99. The Los Angeles figure is higher. The helicopter is the Sikorsky

• **There has been no** worthwhile progress on municipally-provided downtown heliports. While New York officials have been in a wrangle over the issue, a couple of new hotels in California and Texas have provided landing spots, possibly as much for the publicity value as for real utility.

• **The Civil Aeronautics Board** has before it about 60 applications for helicopter routes. Board spokesmen profess to be sympathetic, but it appears that until better equipment is available and the subsidy expense becomes more rea-

BELL HSL

HILLER YH-32

KAMAN HOK-1

SIKORSKY H-34

SIKORSKY S-59

sonable the requests will remain in the file. Recently a CAB examiner recommended that Helicopter Air Service of Chicago be permitted to expand its mail and cargo operation into a passenger-carrying line. If the permit is granted, HAS will be the first to provide service to a downtown heliport.

• **There is a strong** tendency on the part of some military requirements officers, particularly in the Air Force, to look upon the helicopter as an interim aircraft, pending development of a new vehicle that can rise vertically and hover and still be capable of fast forward flight. USAF is seeking proposals for such an improvement. Army also is interested and encouraging the National Advisory Committee for Aeronautics as well as the industry in research on the design of a fixed-wing plane that can operate from an unimproved short landing strip.

Other Growth Problems

Other problems facing the commercial airline with plans for helicopter operation include education of the community and the public to accept the service and intelligent revision of the Civil Air Regulations.

It has been estimated that development of the helicopter to date represents an investment of a quarter of a billion dollars. The commercial subsidy bill now runs almost $3 million a year. It is 12 years since CAB took up its first consideration of a helicopter service application and was forced to postpone a decision because there was a war going on. There is no denying that progress has been made and will continue.

Air Transport Association studies of the trend are based on operating costs per available seat-mile. The figure they give for helicopters in 1945 is .0904 cents. For 1955 it is .0632 cents and they estimate the 1965 figure will be .0361 cents. This is about twice the 1949 operating cost for fixed-wing airplanes.

Military Outlook

Among the military services, the Army continues in its role as the helicopter industry's big hope—for everything from the 40-passenger YH-16, with big turbine engines, to the one-man, easy-to-fly platform on a ducted fan.

In addition to its enthusiasm for the Sikorsky H-34, the Army in 1955 made wide progress with that helicopter's competitor, the Piasecki H-21C. It also is pressing development of a new utility helicopter, the Bell XH-40. Features will be high performance (see charts) and great emphasis on the design of components for long life and overhaul periods, simplified mainte-

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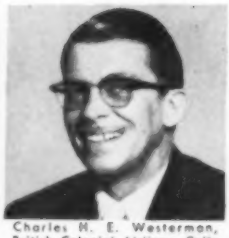

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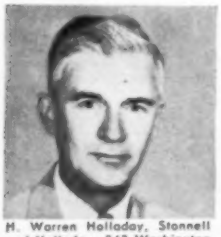

H. Warren Halladay, Stonnell and Halladay, 843 Washington Building, Arlington Towers, Arlington, Virginia

H. Leibee Wheeler, Buffalo Aeronautical Corporation, Buffalo Municipal Airport, Buffalo, New York.

Art Maurer, Arthur Maurer Co., Inc., LaGuardia Field, New York, N. Y.

B. G. Vandre, Van's Air Service, Municipal Airport, St. Cloud, Minnesota.

Robert F. Wood, Newport Air Park, Newport, Rhode Island.

A. M. "Sime" Bertolet, Reading Aviation Service, Inc., Municipal Airport, Reading, Pennsylvania.

Ira Hartzog, Aero-Tex Corporation, 3300 Love Field Drive, Dallas, Texas.

J. B. Redwine, Fairfax Aviation, Inc., 3301 Fairfax Trafficway, Fairfax Airport, Kansas City, Kansas.

Max R. Brand, Aero Commander Dist. (Downtown Airpark), Hangar 3, Municipal Airport, Tulsa, Oklahoma.

E. H. "Ted" Talen, National Aero Sales Corp., Midway Airport, Chicago, Illinois.

Dale Repp, Jr., Aero Southern Corp., 601 Broadway, Nashville, Tennessee.

W. H. "Bill" Buchanan, Sales Manager, Johnson Air Interests, Inc., Horlick-Racine Airport, Racine, Wisconsin.

Louis Humphreville, Executive Aircraft Corporation, Municipal Airport, Pontiac, Michigan.

L. S. McIntire, Vest-Livingston Aircraft, Inc., International Terminal Building, International Airport, Oakland, California.

John A. "Jack" Bauman, Santa Monica Aviation, 3011 Airport Avenue, Municipal Airport, Santa Monica, California.

Herral Bellamy, L. B. Smith Aircraft Corp., Miami International Airport, Miami, Florida.

Lucien M. Taillac, Trans-Aire Corporation, Pan-Air Building, New Orleans Airport, New Orleans, Louisiana.

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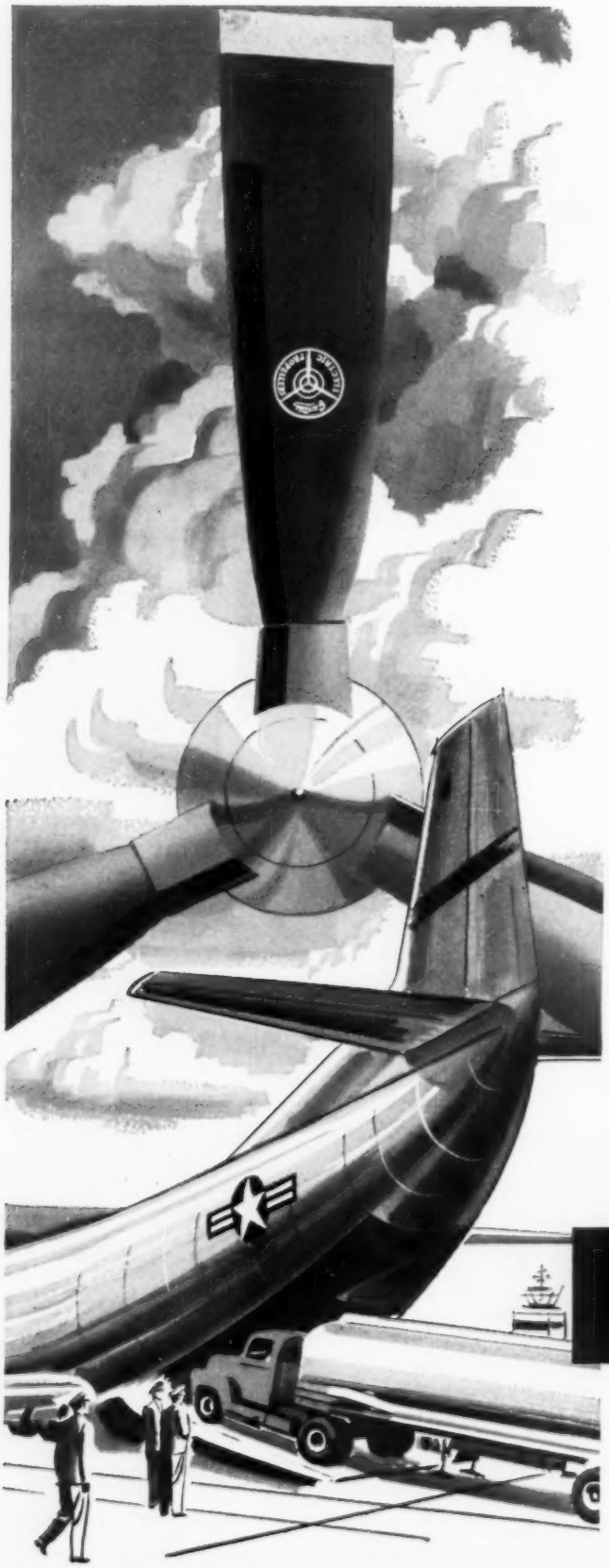

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The Air Force's newest and biggest global carrier is the Douglas C-133 turboprop cargo transport. Over 148 feet long, with wing spread wider than a football field, this high speed, long range aircraft which will lift twice the payload of any military transport now in service, is expected to set new standards of performance as a global carrier of air cargo.

Powered by four turboprop engines, the C-133 is equipped with 3-bladed Curtiss-Wright Turbolectric Propellers – the most efficient means of converting engine power into useful thrust. These propellers, with one-piece extruded, hollow steel blades, provide high performance and a new flexibility of control through full synchronization . . . full feathering, either manual or automatic . . . fast reversing . . . single-lever power control.

Turbolectrics are specified for the major U.S. turboprop engines, which include the T-38, T-49, T-34, T-56 and T-40

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nance and reliability. It will be the first helicopter to use the new Lycoming T53 turbine engine.

Also under contract to Bell Aircraft, Army has under development the XV-3 tilting rotor convertiplane, which has made initial flights as a helicopter and soon will make the transition into horizontal flight. It is estimated this aircraft will be in the 175 mph. class.

In its hunt for lower maintenance costs, Army has placed an order for 10 Cessna helicopters.

U. S. Navy's demand in the helicopter field is centered largely on the need for improved stability, an important factor in performance of its anti-submarine warfare missions. Bulk of Navy's helicopter purchases, however, are for the Marine Corps, where progress in utilizing the aircraft for assault operations continues.

The Marines soon will have an aircraft carrier equipped for helicopter assaults. Their most important aircraft is the Sikorsky HRS (S-55), as it was a year ago. Like the Army and the Navy, the Marines are showing top interest in the Sikorsky HSS (S-58 and H-34), particularly in view of the delays met by the twin-engine HR2S (S-56) in ironing out early developmental "bugs."

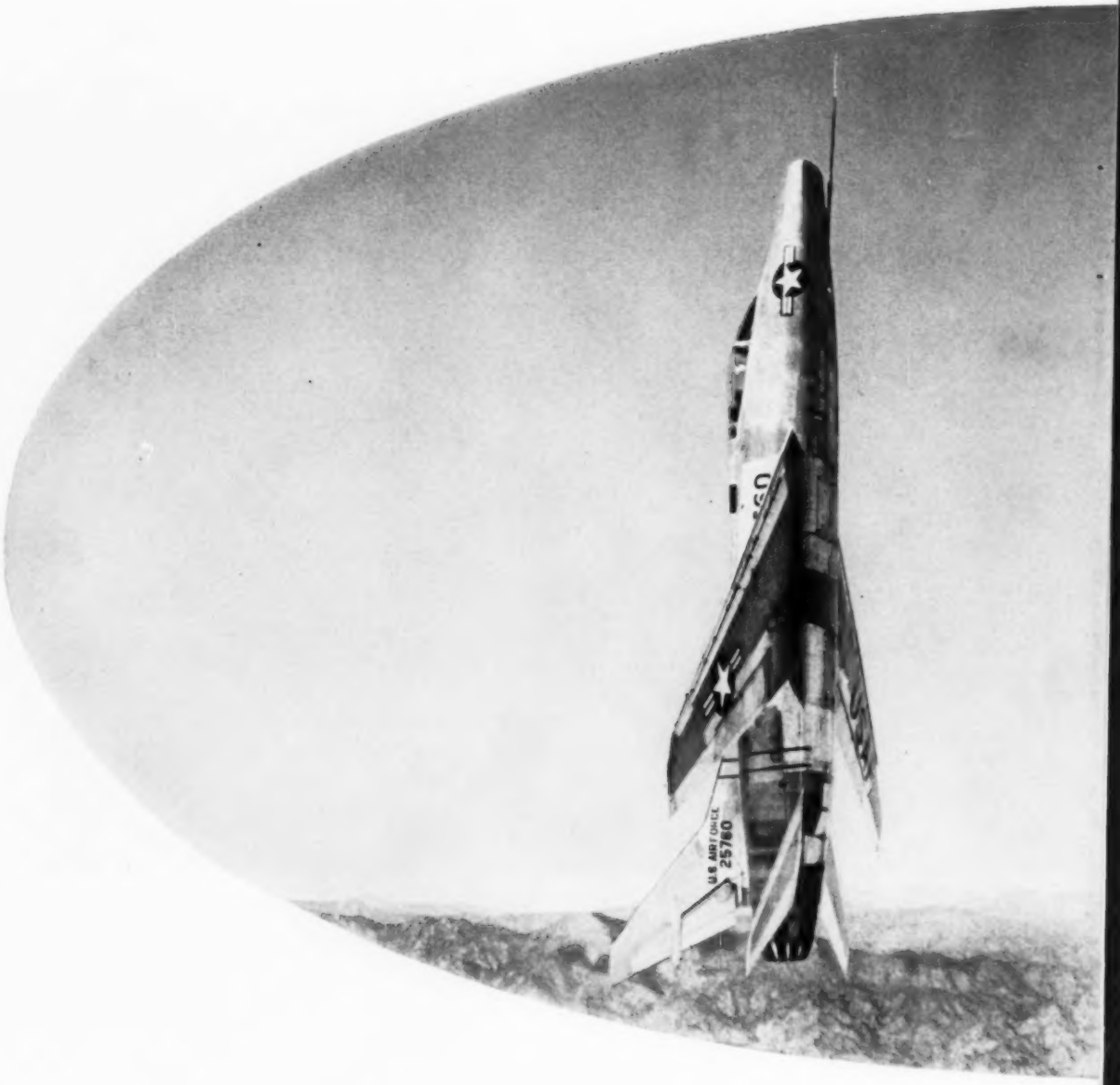
Tactical Air Command's 18th Air Force has made progress in operation of the Piasecki H-21 transport in the past year and demonstrated it convincingly during Exercise Sagebrush, held last fall in Louisiana. Pilot proficiency has improved to the point where formation night flying has become routine. For these missions and search and rescue, USAF uses both the H-21 and the Sikorsky H-19.

CESSNA CH-1

BELL 47G

PIASECKI YH-16A

NORTH AMERICAN HAS BUILT MORE AIRPLANES



SUPERSONIC JETS TODAY

The F-100 SUPER SABRE streaks through the sky at more than 13 miles a minute. The world's first plane able to fight beyond the speed of sound, the F-100 also holds the world's first official supersonic speed record of 822.135 MPH. Hundreds of these fighters, designed and built by North American, are now in active service with our Air Force. A key builder of military aircraft, North American has even faster, more effective aircraft in continuous development for our defense. This work is dispersed throughout North American plants in Los Angeles and Fresno, California . . . and Columbus, Ohio, home of the FJ-series FURY Navy Fighters.

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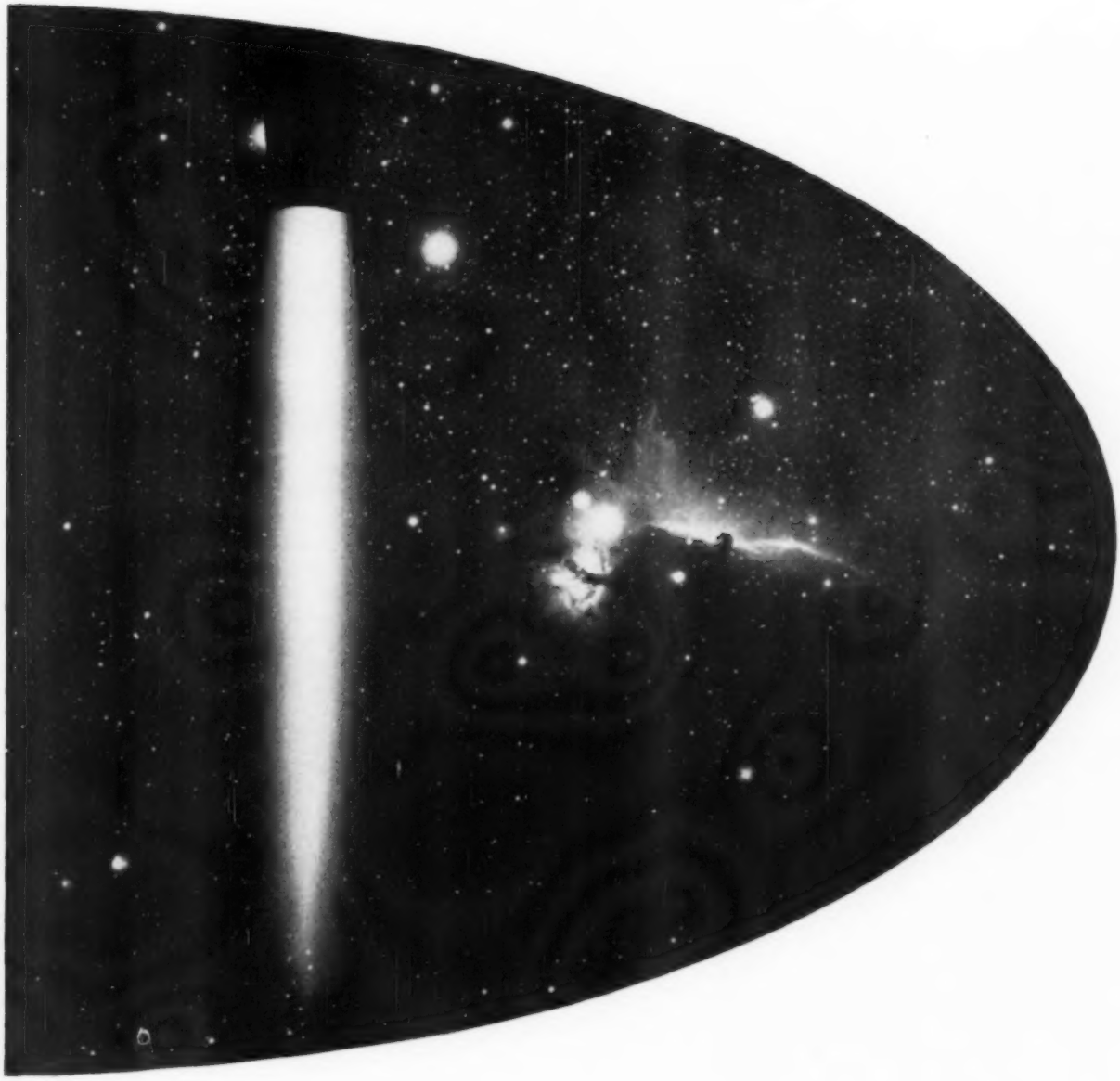

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Voltage	± 1%
RECOVERY TIME	100 milliseconds
VOLTAGE MODULATION	less than .25%
FREQUENCY MODULATION	less than .25%
PHASE BALANCE	per MIL-E-7894A
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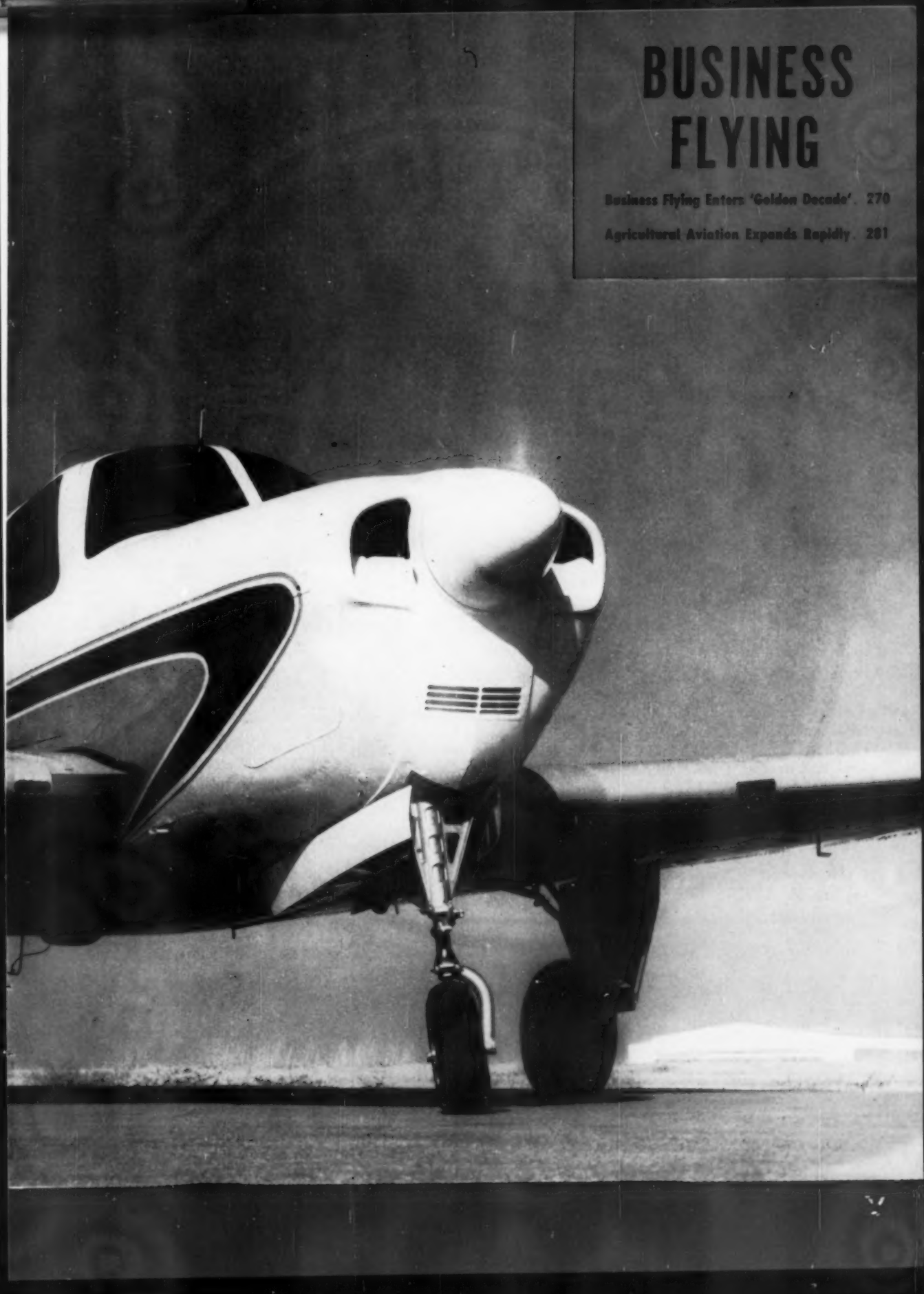
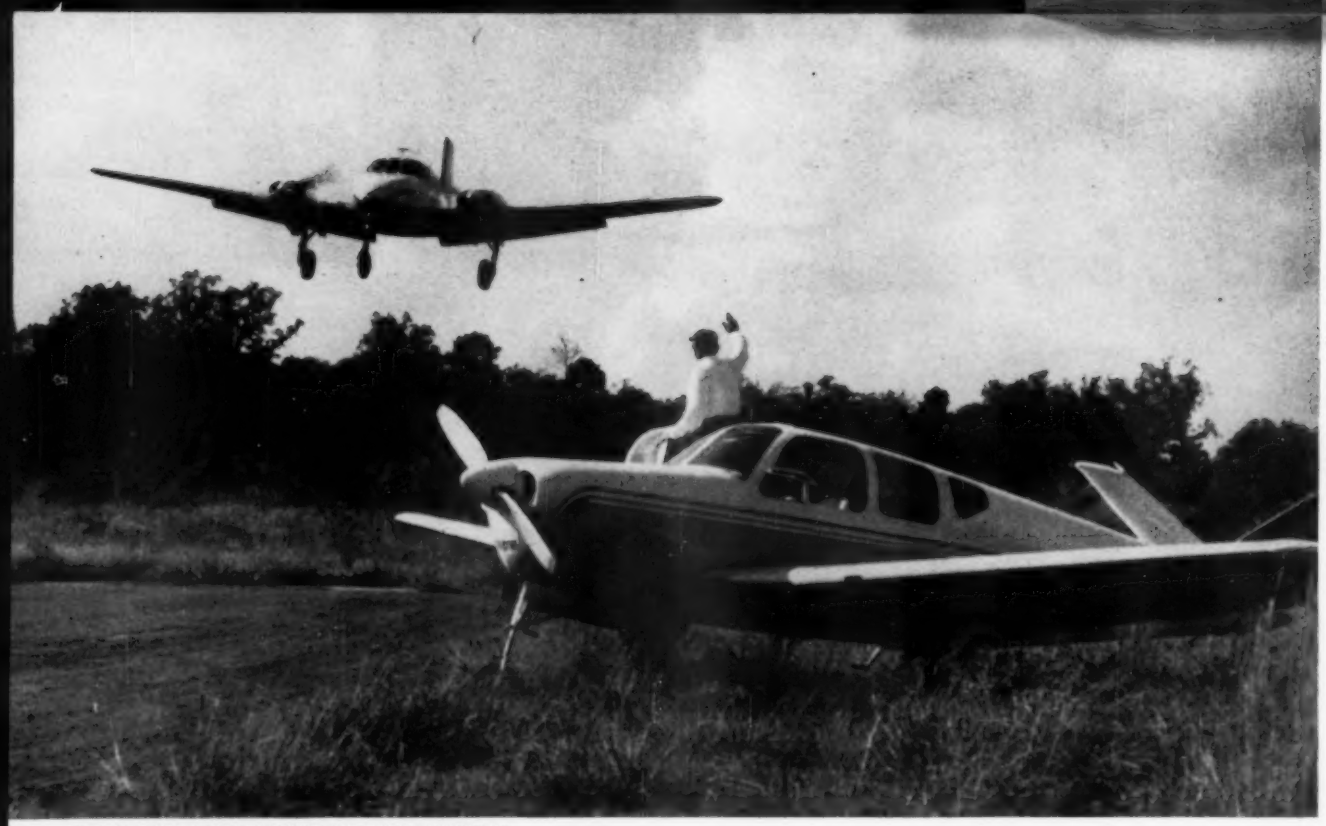
BUSINESS FLYING

Business Flying Enters 'Golden Decade' . 270

Agricultural Aviation Expands Rapidly . 281





BEECH PAIR—TWIN BONANZA AND BONANZA

Business Flying Enters 'Golden Decade'

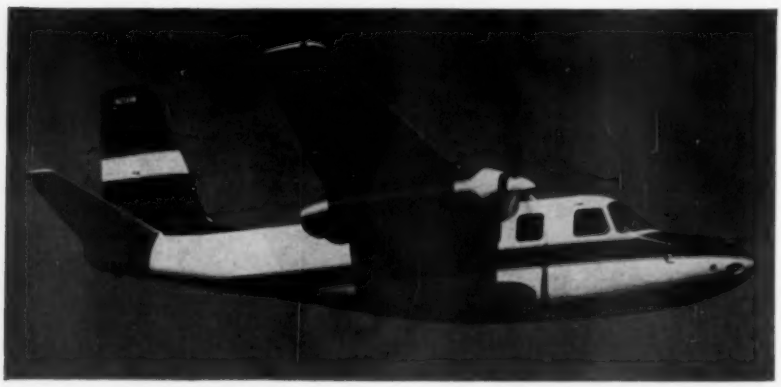
By Erwin J. Bulban

New York—Business and utility aircraft manufacturers have entered a golden decade that will see their sales more than triple to about $240 million annually in 1965, according to the Civil Aeronautics Administration's Office of Planning, Research and Development.

This forecast is too conservative, some industry observers say. They believe this volume will be achieved several years earlier than predicted by government crystal-ball gazers.

OPRD covers itself by acknowledging that the $240 million estimate is a median figure—perhaps $20 million above or below the volume the industry will actually attain 10 years from now. It estimates an aircraft production rate for 1965 of 6,000 airframes weighing 9.6 million lb. The airframe figure could vary by plus-or-minus 500, with airframe weights ranging from a high of 10.4 million lb. to a low of 8.8 million lb.

Blue-sky predictions like these are in accord with forecasts on the future of the U. S. economy being made by spokesmen for other government agencies and by industrial leaders. Early this year President Eisenhower told Congress that the U. S. is on the brink of a $400-billion national economy, a major part of the way toward the $500-billion Gross National Product he believes we will achieve in 1965.



AERO COMMANDER SUPER-680

Keyed to Prosperity

The builders and salesmen of business aircraft are fully aware that their star is firmly hitched to the fortunes of American industry. The record-breaking multi-billion-dollar pace of business facilities expansion and mergers is a key reason some feel CAA's estimates for 1965 are on the conservative side.

Whatever the future, it appears certain that having passed another prosperous year, all segments of the business flying industry are headed for further fat gains in 1956.

• **Aircraft deliveries and sales** in 1955 were approximately $68.2 million at manufacturer's net billing prices and

about $91 million retail, a 57% increase over the previous year. Number of units totaled 4,435, a 44% rise over 1954. Deliveries and sales were the highest since the 1946-1947 period and dollar volume was double that of five years before.

• **Flying hours** by America's business fleet reached an estimated 4.3 million, some 1 million hours more than U. S. domestic airlines, in spite of new records set by the latter. Last year's business flying hours represented an 11% gain over 1954's total of 3,875,000 and is 45% higher than 1951's 2,950,000 hours.

• **Airplane miles** flown by business users in 1955 totaled approximately 645 million compared to 1954's estimated 552,610,000 plane-miles.

National Business Aircraft Assn. reports a rapid increase in membership from about 325 corporations operating planes six months ago to around 400 at present time. The members employ more than 1,500 pilots flying over 1,000 aircraft, of which some two-thirds are multi-engine.

According to the association, owners of business airplanes spent slightly over a half-billion dollars last year on new aircraft, rentals, pilot salaries, insurance, modification and maintenance, fuel, oil and equipment. NBAA says that by 1965 there will be more than 50,000 business planes flying, of which some 8,000-10,000 will be in the multi-engine classification.

CAA's planning group estimates that in 1956, business aircraft will be flying 7.2 million hours and 1,368 million miles.

Sales and Backlogs

A significant point about last year's production of 4,435 airframes was that the total included 809 twin-engine aircraft as a result of the industry getting into its stride for the first year on light-twin output. In the past three years it has delivered over 1,500 twins. These faster and larger airplanes will be a major factor in building an up-spiralling rate of plane-miles and hours in years to come.

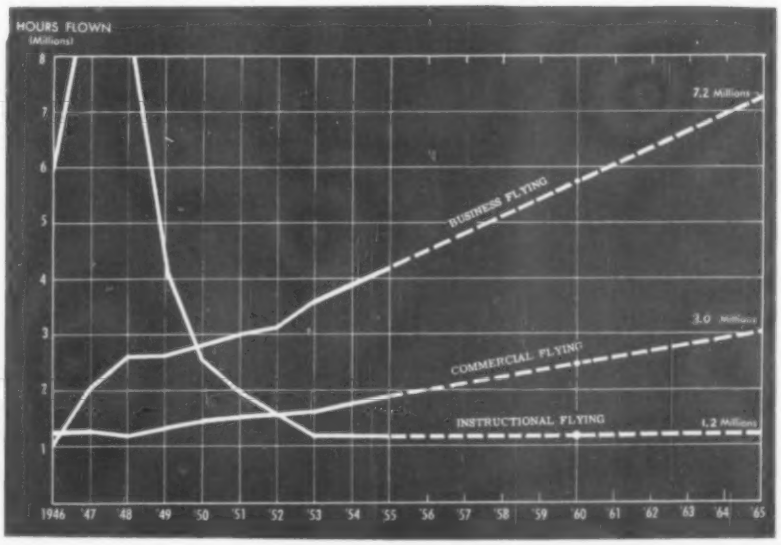
Manufacturers registered spectacular gains over the previous year's business. Beech commercial sales reached $27,245,940 in 1955, a gain of approximately 40% over the previous year; Cessna went to $21,647,311, an increase of 56%, and Piper sold $14,839,400 worth of commercial planes and spares compared with the previous year's $7,618,736, despite a strike last August that cut 1955 production by about 200 planes. Spares shipments to distributors also reached good proportions: Beech, $2,481,011; Cessna, $1,247,206 and Piper, $710,080.

Each of the "Big Three" reported

CESSNA 620

PIPER APACHE

BUSINESS FLYING FORECAST BY CAA



Stretching the Path of an Electronic Pulse

Military coding equipment takes one pulse and inserts it into a delay line and in effect sends it over a number of paths, each of different lengths. Combining the output of the paths gives a pulse train with pulses spaced in accordance with artificial length of the path. Ordinarily the flexibility of the equipment is limited by the fixed taps in the delay line and the accuracy is established by auxiliary circuitry.

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substantial backlogs in the beginning of 1956: Beech, over $11.5 million; Cessna, over $10 million; Piper, $11 million.

Beech and Piper state that they expect their 1956 sales of airplanes and parts to exceed $32 million and $20 million respectively.

The heavy demand for new airplanes is certain to result in a substantially higher number of airframes this year. Beech, normally cautious about predicting output, says that its 1956 production will exceed totals for 1955. Cessna says that it is turning out 13 airplanes per working day, including one twin-engine 310. Piper says that it is rolling out eight single-engine airplanes each working day in addition to eight twin-engine Apaches weekly and expects to step up the latter to 10 a week this spring.

A healthy sign has been the continued high-level production by most companies through the winter, usually a period of slow-down until spring.

Export Business Climbs

Manufacturers also are quick to point out a sizable climb in export business, with the signs pointing toward increased use of aircraft by foreign executives and for agricultural purposes.

An encouraging move has been New Zealand's relaxation of a previous stern attitude towards import of American aircraft. A huge program of aerial fertilizing of soil, with top-level government support, is one of the reasons for this change of heart, observers report.

Piper recently sold eleven PA-18A agricultural airplanes to New Zealand, in addition to seven 95-hp. Super Cubs for aero clubs, three Tri-Pacers and an Apache. Piper's foreign sales are up about 33% over last year.

Beech's 1955 exports increased 13% over 1954, for a dollar volume of $6,422,288.

A prime reason for the phenomenal business flying boom has been the development of a variety of models in a wide range of prices to fill nearly every performance and budget requirement. Other factors are the low operating costs and the enticement of tax savings attained by writing off the use of the airplanes as a business expense.

Manufacturers last year were probably more active than ever in developing their lines to increase their penetrations of the market.

• **Cessna brought out** two new versions of its 170 and 180 four-placers fitted with tricycle landing gear. The aim was to simplify landing and takeoff of the airplanes to keep pace with development of electronic aids that have made flying easier.

• **Piper is completing** a new four-place all-metal PA-24 Comanche to be offered next year to customers who have been looking for a faster and roomier airplane than the Tri-Pacer.

• **Aero Design & Engineering Corp.** will be turning out two new versions of its Aero Commander twin—a faster 560-A and a new 580-A with supercharged Lycomings providing a 230-mph. cruise speed and increased capabilities at high-altitudes.

• **Beech is offering** a more powerful Twin-Bonanza, providing higher payloads and 203-mph. cruise speed, in addition to improved versions of the Super 18 and Bonanza.

Pressurized Cessna 620

One of the top events this year will be rollout of Cessna's new four-engine Model 620 business transport, expected to start flight tests next month.

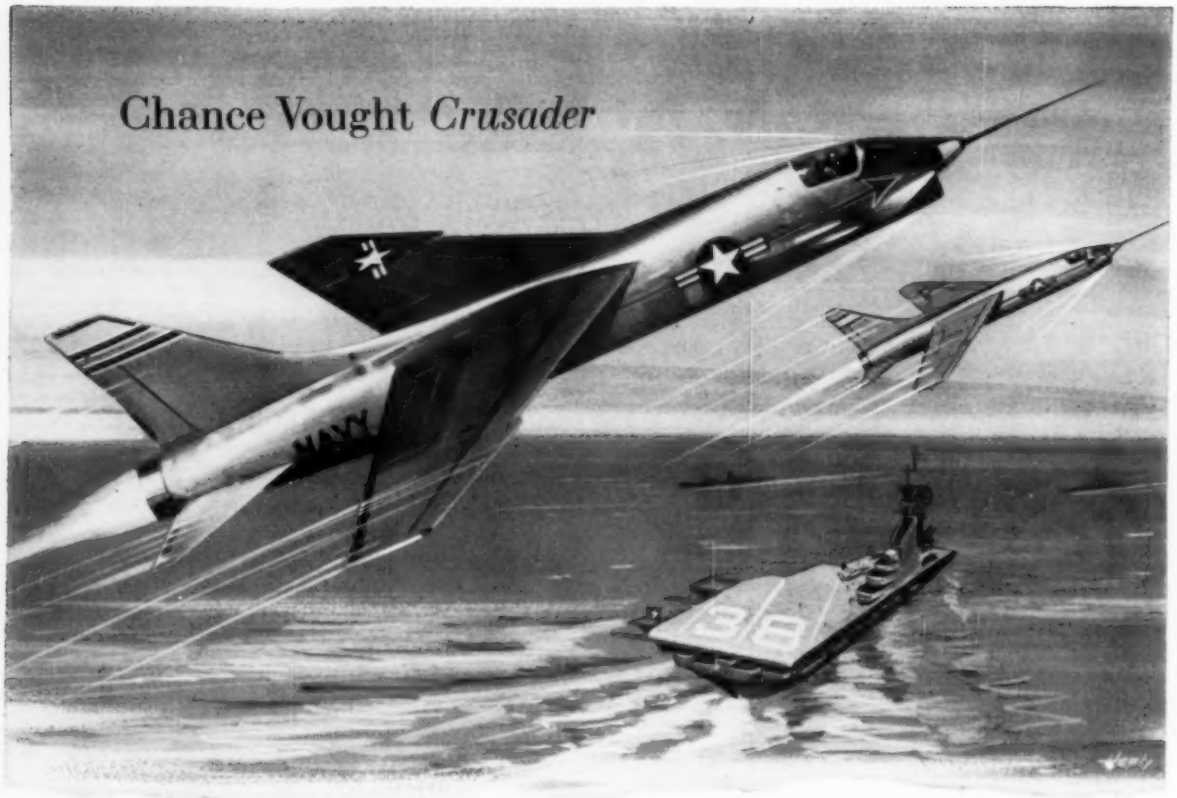
In addition to providing Cessna with

BUSINESS AND UTILITY PLANE SHIPMENTS

January—December 1955

	Complete Aircraft Jan.-Dec.	Complete Aircraft Dec.	Builder's Net Billing Price Jan.-Dec.	Builder's Net Billing Price Dec.
Aero Design				
560	42	.	$5,059,400	$536,400
560A	31	9		
Beech				
Bonanza F35	437	49		
D18S	1	...		
E18S	85	6	24,892,858	2,190,858
Twin-Bonanza C50	131	11		
Model 45 Trainer	26	...		
Callair				
Model A5A	2	...		
Model A4	7	2	55,960	16,960
Model S1B1	2	1		
Cessna				
170	448	17		
172	173	97		
180	880	44		
195	15	...	21,880,000	2,223,000
195B	1	...		
305	1	...		
310	228	26		
Mooney				
M18C	32	1		
M20	9	3	180,156	32,156
Piper				
Super Cub	605	68		
Pacer & Tri-Pacer	974	93	16,007,765	1,736,765
Apache	291	32		
Taylorcraft				
Tourist 15A	4	...		
Model 20	10	1	119,639	9,639
Totals	4,435	460	$68,195,778	$6,745,778

CESSNA 310



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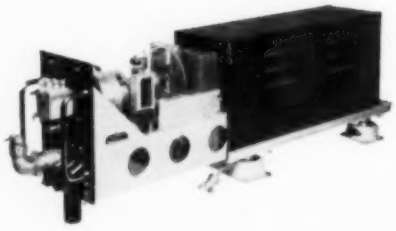

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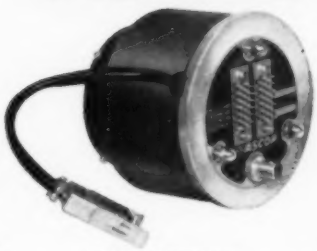
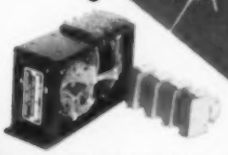
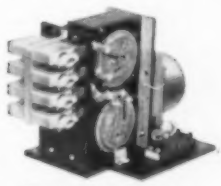


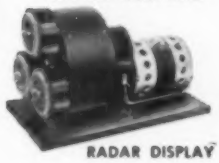
TELEMETERING



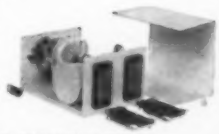
STRAIN GAUGE SAMPLING



THERMO-COUPLING



RADAR DISPLAY



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the broadest line of any business airplane builder, the new eight-to-ten-passenger 620 represents a constructive step towards filling the need for a modern replacement for the hundreds of prewar and wartime converted airliners and bombers that up to now have been the prime source of supply of large-capacity, highspeed long-range transports for corporation personnel.

The 620 is aimed at a market area that has been extremely critical of the industry's supposed lack of initiative in fulfilling its requirements. One of the most vocal of these groups is the National Business Aircraft Assn., whose 400 members operate some 1,000 airplanes and comprise the largest single group of users of updated obsolete multi-engine transports.

Top-level NBAA officials have said that the 620's design speed of 250 mph. falls about 50 mph. below their requirement and they have been somewhat critical of its four-engine layout, saying that they prefer a twin configuration.

However, should the 620 successfully pass its tests, it appears fairly certain that it will sell well. "This is not the airplane I want," one of its harshest critics told AVIATION WEEK, "but I wish I had one of them now."

If nothing else, the Model 620 will introduce a competitive factor that will not be ignored by other manufacturers and should spur development of the ultimate configuration.

Small Jet Transport

There are possibilities the small jet transport may come as a result of still another factor: USAF's interest in a so-called "C-45 replacement," jet-powered and seating about eight passengers. Air Research & Development Command is planning a formal presentation to the industry for such an airplane having a speed of at least 400 knots and range of at least 1,000 miles (AW Feb. 13, p. 32).

BEECHCRAFT SUPER 18

These specifications are definitely in line with desires of large corporation airplane operators. Should USAF put this type of airplane into production, the builder would be in a favorable position to offer a civil version with a great deal of the risk of development and tooling written off.

New Entries

Some manufacturers, notably North American Aviation, Inc., and Fairchild Airplane Division, have been polling business plane users on a similar configuration (AW Oct. 17, 1955, p. 55) and North American has even built a full-scale mockup of such an executive aircraft.

Beech is known to have designs on the drawing boards, but is not making any proposals to civilian operators.

However, it is doubtful that business flyers will beat the airlines in placing jet transports in operation.

Equipment manufacturers, particularly those in the electronic field, have been happily caught up in the business flying boom, and many who have catered almost exclusively to the military and airlines are now busy revising their research and development and sales efforts to enter this field or increase their participation.

Those who deal with this market say without reservation that the standard of equipment on business transports would be the envy of most airline pilots. And they also note that selling does not involve the red tape and delays that they encounter with the airlines. Time from contact to sale is not only shorter, but the potential in many cases is higher. For this reason, most manufacturers are busy studying their airline-type and military-type equipment with a view towards its use by business flyers.

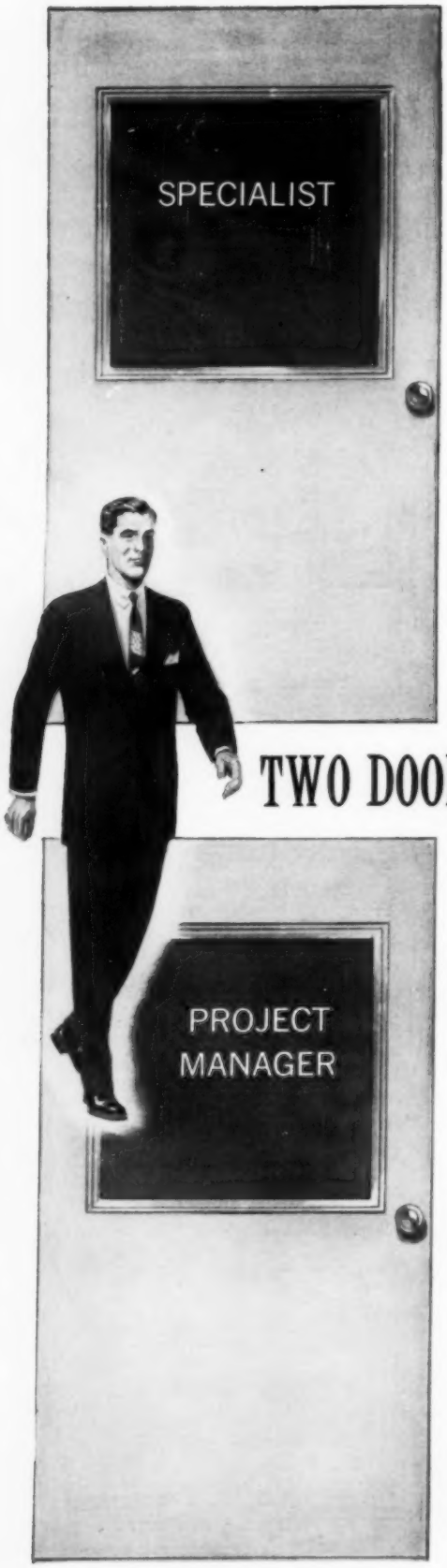
Navigation Aids Needed

Corporation pilots have been quick to install considerable amounts of the latest radio, navigation and flying aids because of the very nature of their nonsked operation, both off the airways where lack of familiarity with the geography and fewer ground facilities calls for increased instrumentation and into congested terminal areas.

The business plane's need for equipment has been the source of increasingly serious installation and weight problems; on some of the lighter airplanes, the equipment has cut deeply into available payload. Manufacturers are becoming aware of the need for miniaturization and light weight. In the case of the light twins, where space and gross weight requirements are even

PIPER PA-22 TRI-PACER

CESSNA 172



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more critical, it is obvious that an entire new breed of products will be needed to do the required job.

One of the hottest items being sought by light-twin builders is a lightweight low-cost autopilot and the competition in this field is growing fast. A Cessna representative told AVIATION WEEK that his company is watching the field closely and hopes to be able to select at least two models out of the half dozen or so in development.

Detailed dollar figures on equipment installations are difficult to get because many suppliers won't separate commercial from military sales, or break down division activities. Airframe manufacturers say it is very difficult to put together this data. Also, much equipment is installed either by the airplane distributor or at another shop.

Piper reports that last year it spent $3,433,825 on radio and engine purchases; Bendix Radio Division says its corporation aircraft business went up 32% last year compared to 1954; Lear says its sales dollar volume has gone up over 100%, including deliveries of Learstar transports. Edo Corp., which introduced an amphibious float for the Cessna 180 last year, delivered about 40 sets in 1955 and plans to build 154 sets in 1956. It also is designing a set that could go on a modified Tri-Pacer.

Airport Facilities Inadequate

In anticipation of the growing volume of business airplane service and maintenance requirements, millions of dollars are being spent in private funds by large operators who have been catering to corporation flyers. However, the picture is not all rosy. There is a definite lack of airport facilities. Some firms have had to build their own airstrips adjacent to their plants.

Many communities do not understand this new revolution in aviation and refuse to encourage facilities expansion at municipal airports, sometimes holding a club over the operator's head by maintaining short-term leases that in many instances are kept on a month-to-month basis.

One of the dark spots in the national picture is Kansas City Municipal Airport, where scores of business aircraft are forced to remain parked outside hangars because the available space is taken up.

With one exception, which has been under local fire on charges of favoritism, the fixed-base operators have been working at the field without leases. Airline growth at the field, encouraged by the municipality, is gradually encroaching upon the current fixed-base facilities.

The business and private aircraft service operators have won a small measure of respite from the authorities, who have set aside a 20-acre site for them on the west side of the field. However, lease terms are such, the operators claim, that they have been unable to interest banks or insurance firms in investing capital to erect new facilities. The plane owners, who take an understandably dim view of having their costly equipment exposed to the elements the yearround, have offered to finance construction of their own hangars if the city would assure them of a long-term lease. These offers have been met by indecision or outright refusal.

An airport service operator at Kansas City says that numerous concerns have delayed purchasing airplanes until there is a change in the city's attitude. As it is, many companies are forced to take their aircraft to service facilities hundreds of miles away for maintenance and overhaul because of the lack of space, he says.

At some airports, the service operator's business is hurt by petty annoyances, such as not permitting corporate aircraft to taxi near administration building gates to discharge or take on passengers.

On the bright side are such business plane service facilities expansions as the $1-million Skymotive terminal at Chicago and the $600,000 hangar and service area opened last month by Atlantic Aviation Service at Wilmington, Del.

The Port of New York Authority plans gradual expansion of corporate aircraft facilities at its airports. It has already established one large operator at the former Marine Terminal hangar at LaGuardia Airport and spokesmen say this busy airline terminal will take on additional business flying services as demand grows.

Last year there were over 81,000 corporate plane movements in and out of PNYA's four metropolitan New York area fields, compared with 73,577 in 1954. The authority estimates that in 1960 business plane movements at its airports will increase to about 105,000 annually.

A trend toward more elaborate base facilities to handle this market is inevitable as corporate flying increases and larger and more complex aircraft join the predicted fleet of some 25,000 aircraft, including 2,600 multi-engine planes. The facilities will be required to handle large numbers of airplanes unknown to the industry a few years ago and carrying equipment many fixed base operators have never been concerned with before.

The manufacturers realize that top-notch nationwide servicing facilities will be necessary to deal with this important market. As a result many aircraft and equipment makers are pressing their dealers to improve facilities, while others are setting up authorized factory service centers as sole sources for key replacement parts.

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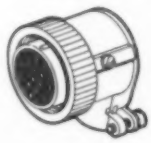

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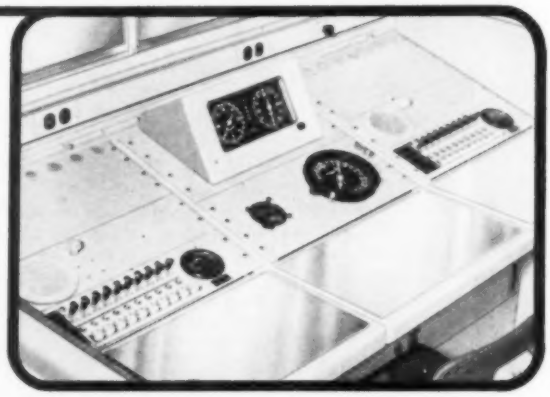

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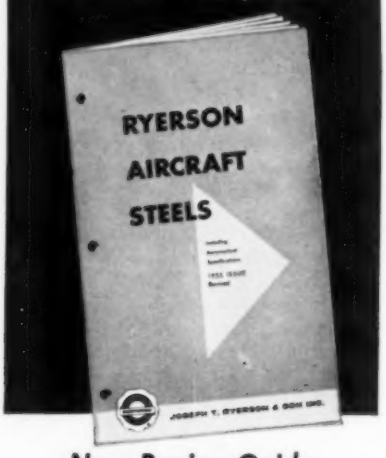

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Agricultural Aviation Expands Rapidly

Agricultural aviation—A $70-million business today—has grown from one airplane treating one crop in 1919, to a fleet of 4,200 planes treating over 200 types of produce on 40 million acres.

The signs indicate that in 10 years the aerial applicators will probably double 1955's three-quarters of a million hours flown. And 1955 appears to have been the best year to date.

Actually, flying hours may be losing some of their meaning. Experts point out that customer demands for heavier coverage per acre are bringing payloads —and dollar volumes—up sharply. So an increase in flying hours will become a smaller factor than pounds or gallons of chemicals dropped in figuring the applicator's growth.

A few years ago it was normal procedure to dispense about 50 lb. of rice seed per acre and about an equal amount of fertilizer. Now the aerial applicator is putting down 150 lb. of seed and up to 400 lb. of fertilizer per acre.

The only factors likely to interrupt the upward trend of agricultural aviation fall in the category of "acts of God"—a big drought or unseasonable bad weather or non-appearance of expected insects, and the applicator's season topples.

Planes and Equipment

The market is building for new aircraft; manufacturers are keeping closer touch with applicators than ever before and this year about a half-dozen new airplanes will be undergoing field evaluation. These include new designs or adaptations by Callair, Cessna, Fletcher, Hiller, Piper, Transland and Lamson Aircraft.

Not only will the manufacturers be supplying aircraft, but the dispensing equipment to go with them. The experts say that the approximately 4,200 aircraft registered as full-time agricultural planes are fitted with almost as many different kinds of dispensing equipment, much of it home-made.

New aircraft will probably not only allow the applicator to do a much more efficient job, but also provide increased safety. Much of today's fleet, comprising 32 different types, is composed of greatly modified World War II trainers and prewar airplanes which don't have the crash-survival features of the newcomers. Those close to the industry say that aerial applicators are experiencing one fatality in every 16,000 flying hours and one crash resulting in major damage about every 2,100 flying hours.

Safety Factors

Much of this accident rate is due to lack of training. The industry is aware of this shortcoming and there has been a buildup in specialized schools to overcome this serious handicap. More than a dozen universities and land-grant colleges are giving two- and three-day short courses in agricultural aviation. The most elaborate course is the one at Texas A&M College, which provides six weeks of instruction, including entomology, agronomy, chemicals and 30 hours of flight training on several different types of aircraft.

The school has found that it takes pilots about six to 10 hours to be broken of their previous flying habits and to begin to fly properly for aerial application. The aircraft are fitted with stall-warning equipment, an item credited with keeping accidents during training down to only a few minor incidents.

Stalls are credited with causing 32% of aerial applicator crashes; 39% are tallied against hitting obstructions; 24% are reported as "mechanical failures," and the remainder are caused by toxic effects of the chemicals carried.

Fatigue is the most prevalent hazard and is the biggest factor in pilots getting into dangerous situations. It is an occupational "disease," the experts say. One of them notes that aerial application is "the nearest thing to air-to-ground warfare, except that you fight

PIPER PA-18A

TRANSLAND AG-2

bugs instead of people." The tensions involved in flying at minimum altitudes, watching out for obstructions, keeping track of swaths being sown, all tend to aggravate the fatigue factor.

Spray vs. Dust

The trend in dispensing chemicals is towards increasing use of liquids and less dependence upon dust. Main reasons for the switch: Spray can be handled at higher wind velocities than permissible for dusting, and sprays generally adhere better.

Applicators would like to see dust and fertilizer manufacturers develop formulas with higher concentrations of active chemicals to carrier material. Current large proportions of filler necessary for proper application take a large proportion of the airplane's chemical payload, they say.

Instructional flying dipped 1.3% in 1955 to an estimated 1,275,000 hours, compared with the previous year's 1,292,000 hr. CAA expects the figure to stabilize at about 1.2 million hours through 1965.

Almost all segments of the industry are concerned over the low level of interest in flying careers among America's youth. Spokesmen for the National Business Aircraft Assn. have said that this trend may have a detrimental effect on corporation flying growth if the situation continues. NBAA President Henry Boggess is convinced that interest must be stimulated in young people before they leave school.

This attitude is also shared by National Aviation Trades Assn., which has proposed that the Air Force incorporate a flying training program into its Reserve Officers Training Corps, which could be activated at some 180 colleges throughout the country. NATA's plan is to use local fixed-base operators to provide ROTC students with 35 hours of flight time in light aircraft. Not only would this spur their interest in becoming pilots, but the process would also serve to screen out unlikely prospects, NATA says.

Although the Air Force has indicated its desire for such a program, there has been disagreement over the price to be paid operators for supplying the flight time. Air Force has proposed about $370 per student, which NATA members say is below what it would cost them to provide the flight time.

Personal Flying

Personal flying for pleasure last year showed a 2.9% gain over 1954 and accounted for approximately 1,975,000 hours. Civil Aeronautics Administration planners expect the trend to continue upward, reaching about 2.6 million flying hours in 1965.

This rise in pleasure flying started in 1953, following a decline dating to 1949 when it dropped 0.3% from 1948's 2,787,000 hours, slid approximately 13.7% in 1950, 16% in 1951 and another 9.1% the following year.

Most of the present pleasure flying is an auxiliary use of the single-engine business airplane. The growth trend will be a result of more of these planes coming into use rather than any major increase in the use of planes wholly for pleasure.

The aircraft industry is generally too occupied supplying the tremendous demand for business aircraft to pay much attention to development of low-cost sport planes. Obviously the major source of airplanes for the enthusiast for many years will continue to be "second-hand" models.

There have been attempts to develop a solid "built-it-yourself" movement, either through kits or sale of plans on ultra-light types, mostly of one or two-place layout. Although proponents of the movement say that the trend is growing rapidly, it is difficult to gage accurately because of lack of statistics.

Indications are that many of the home-built projects are terminated somewhere prior to completion when the builder finds that he has bitten off more than he can digest.

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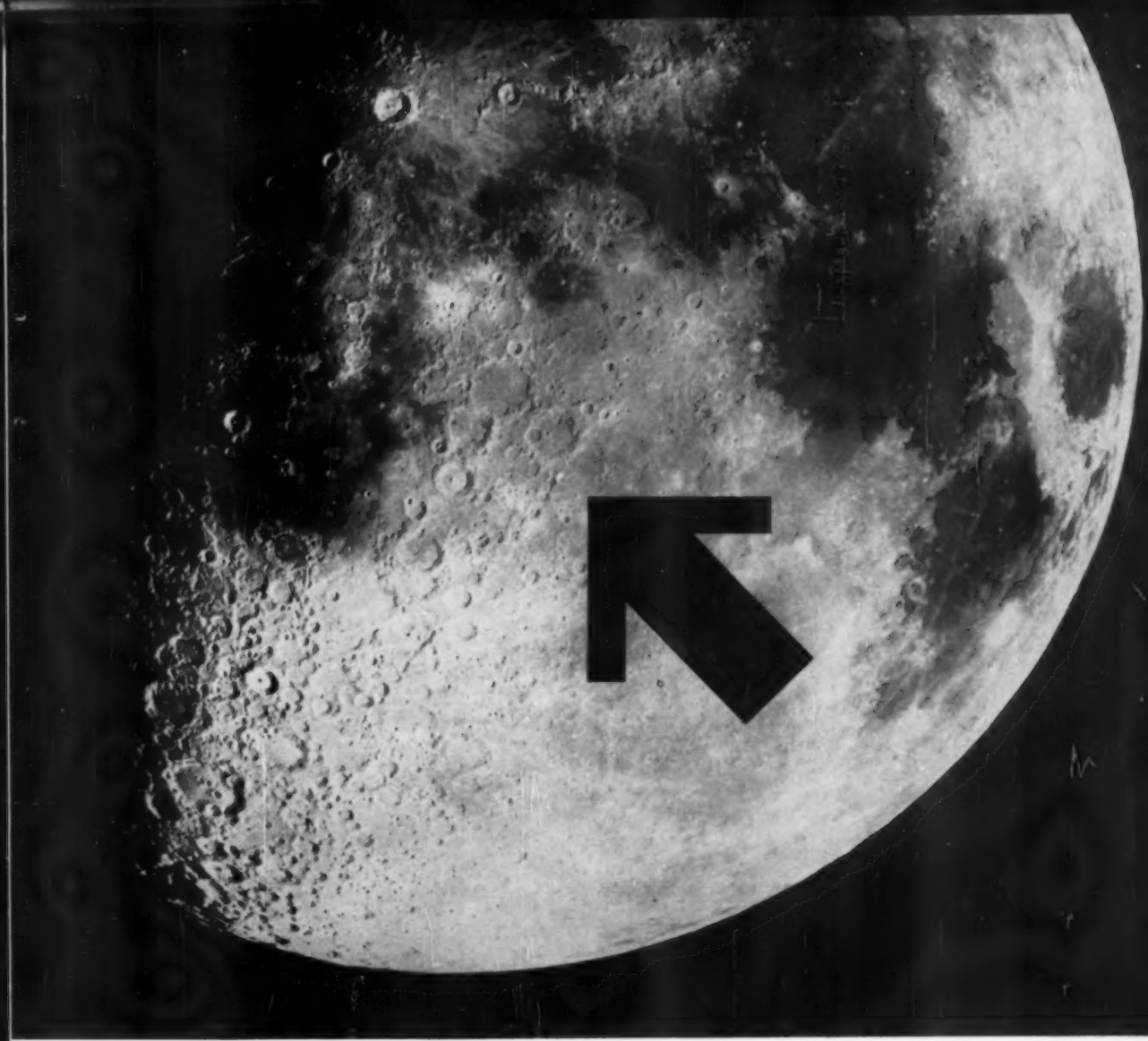

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FOREIGN

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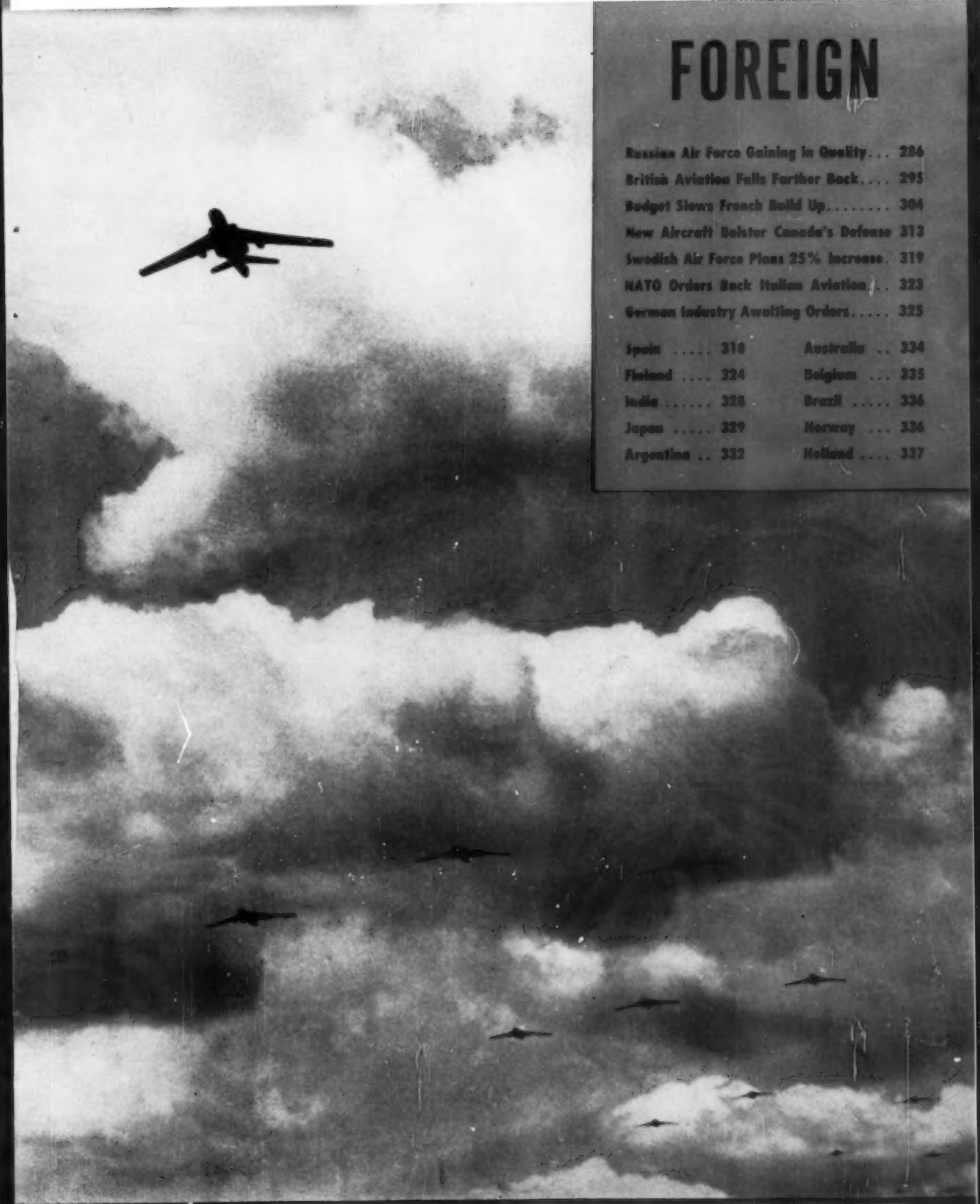


RUSSIAN BADGERS

ILYUSHIN 14 TRANSPORT at New Delhi, India, carried Communist leaders Bulganin and Khruschev on propaganda tour.

Russian Air Force Now Gaining in Quality

By Robert Hotz

The Russian air force is now approaching the U.S. Air Force in quality after having surpassed it in quantity of modern jet planes several years ago.

This warning was delivered during 1955 and early 1956 by top USAF leaders including Gen. Nathan F. Twining, chief of staff, Gen. Thomas D. White, vice chief of staff, Lieut. Gen. Thomas Power, chief of the Air Research and Development Command, and Trevor Gardner, who recently resigned as Assistant USAF Secretary for Research and Development. These warnings came from the men who know the most about both USAF's capabilities and the Russian air force. They have been repeated clearly and unequivocally during the past six months in a manner calculated to arouse and warn the American people and their Congress into taking the necessary action to surpass the Russian challenge before it is too late.

After pouring a decade of expanding technical effort into their program to build a modern high-speed, long-ranging jet air force equipped with nuclear weapons, the Russians reached a significant pay-off stage during 1955. Here are the critical achievements they unveiled during the last year:

• **Guided missiles.** Russians revealed they have defensive missiles in production similar to the Army Nike and have test fired a 900 mile range ballistic missile over a six month period, indicating it is in the development test stage.

• **Intercontinental turboprop bomber.** The four-engine Bear is now in production and squadron service. Along with the USAF B-36 the Bear is the only in-service bomber capable of carrying nuclear weapons between Russia and the U.S. and returning without refueling.

• **All-weather interceptors.** The twin-jet Flashlight appeared publicly in production quantities during 1955. Flashlight revealed for the first time the substantial progress the Russians have made in airborne radar.

BEAR AND MiG-17 FRESCOES

• **Supersonic day fighters.** The Farmer, 1,000-mph. interceptor, also appeared in production quantities during 1955. It features 60 degree swept back wings and a low slung horizontal slab tail that are characteristic of the latest USAF supersonic interceptors such as the Vought Crusader and North American Super Sabre.

Bomber Production Lead

Also during 1955 the Russian air force pulled ahead of USAF in production of heavy jet bombers. Gen. Twining told Congress early this year that the Soviet air force now has more of its four-jet Bisons than USAF has B-52s "and they can maintain this advantage for some time if they keep on the production curve we are now predicting."

In comparing USAF's current strength and planned production against the Russians in each major plane type, Gen. Twining made the most detailed statement yet offered either Congress or the American public on the comparative strength of the two international competitors. Gen Twining's box score:

• **Russia leads in Bison** production compared with USAF B-52 production.

• **Russia leads in supersonic** jet fighter production.

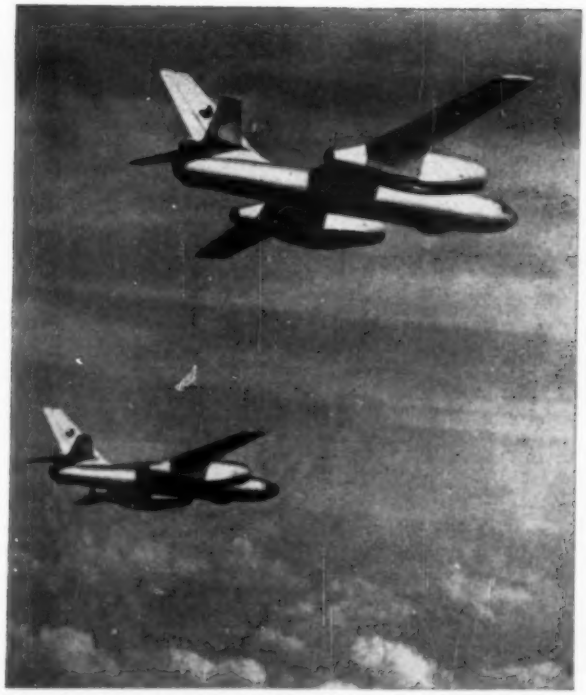
• **Russia leads in light jet** bomber production compared with USAF B-57.

• **USAF leads in B-36** bombers in service but Russia will gain the lead with Bear turboprop bombers within two years.

• **USAF leads in all-weather** fighter production but the Russians can close this gap and take the lead in the next two or three years.

• **USAF leads in B-47** medium jet bomber production compared to Russian Badger production.

The overall Russian airpower picture indicates a visible margin of inferiority



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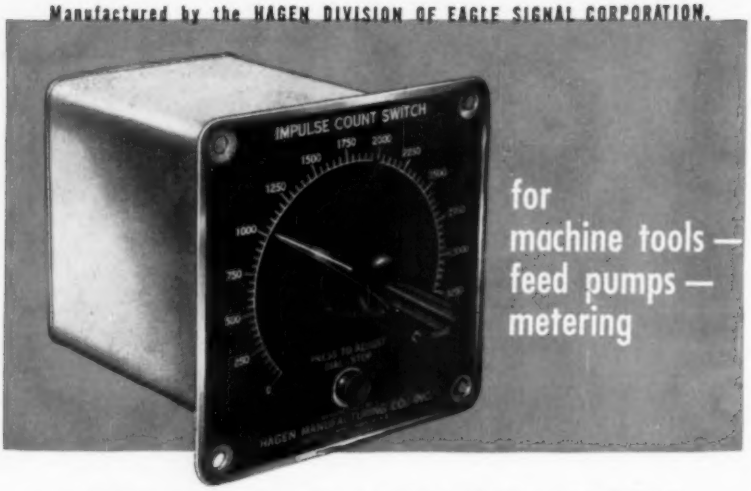

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against total U. S. military airpower. But it is the rate at which the Russians are narrowing this gap that is significant and poses the real danger.

"I cannot deny that the Soviets are narrowing our gap of superiority," Gen. Twining recently told the Senate Armed Services Committee. "They have long since passed us in quantity and are making remarkable strides in quality.

"In our build-up of airpower we have retained a lead in quality. The Soviets are attempting to close this gap by greatly increasing their research and development efforts.

"This is our real concern. It is apparent that they are putting more men and money into this battle of the laboratories than we are."

Bison and B-52 Histories

The case histories of the Russian Bison bomber and the USAF B-52 provide a good illustration of the relative rates of progress which will enable the Russians to catch and surpass USAF unless radical changes in pace occur. Gen. White stated flatly that the Russians had cut their lead time on the Bison to just half of what it took USAF to get the B-52 off the drawing board into production.

Currently the Russians have more Bisons in service than USAF has B-52s. Bison production has been running at about 15 planes a month and is increasing to 25 a month.

USAF took delivery on four B-52s in January and had programmed production at a rate of 14 planes a month including both Boeing plants at Seattle and Wichita. As a result of the appearance of Bison formations during the May 1955 Moscow air shows, USAF has increased its B-52 program to 17 planes a month. But even when this peak B-52 production rate is reached late this year it will still be well below the current Russian Bison rate.

Unless further changes are made Russia will have a larger long-range jet bomber striking force in 1958 than USAF. Another indication of the scope of the Russian development program is the fact that while USAF was concentrating on developing and producing the B-47 and B-52 types, the Russians not only brought through successful developments in both these fields but also developed two types of turboprop bombers—one a major modification of the TU-4 bomber incorporating a longer fuselage, higher gross weight and four 5,500 eshp. turboprop engines and the other the swept-wing Bear, incorporating a general design plan very similar to the B-52 and powered by four 6,000 eshp. turboprops.

In the fighter field, since the mass production era of the MiG-15 (1948-53) the scope of the Russian development

program has been indicated by the wide variety of prototypes flying. At one time in 1955 a total of 21 new fighter prototypes were identified at Russian experimental flight test centers. Out of this wide variety of experimental types came a decision to concentrate production on a single type with a small production run for a back-up type.

Thus the MiG-15 was succeeded in the production cycle by the MiG-17 which appeared in quantity during 1954. The MiG-17 in turn has been succeeded by the Yak-25 (Farmer) which first appeared publicly in the 1955 air shows and is now in widespread squadron service with combat units.

During this same cycle USAF took delivery on less than 7,000 F-86 Sabres contemporary with the 15,000 plane production run of the MiG-15 and now has only two operational units equipped with a few hundred Super Sabre F-100s compared to several thousand Russian Farmers in Red air force units.

Production of F-100 Super Sabres at North American Aviation, Inc. plants at Columbus and Inglewood is now running at less than 100 planes a month while the Farmer is being rolled out at a rate of about 300 planes a month.

In the all-weather interceptor class the Russians are still in the process of catching up to USAF quantity and quality. Their twin jet Flashlight now in widespread service has not yet been produced in the total quantity of the combined Northrop F-89, Lockheed F-94C and North American F-86D. Although the Russians have new all-weather protoypes in the flight test stage it does not now appear likely that they will get one into production that will match either the operational capability or the combat-readiness of the Convair F-102A and the F-102B.

Helicopter Progress

Russians have pulled abreast of American development and production in the rotary wing field, displaying production quantities of a large twin rotor helicopter characteristic of the Piasecki design trend. This Horse helicopter carried and unloaded jeeps, weapons carriers and field artillery from an integral ramp in its rear. The large single rotor Hound, following the Sikorsky design trend, has been in wide scale operational service including the Arctic for several years.

Coincident with their rapid development and production achievements in new aerial weapons the Russians are facing the inevitable growing pains of an air force that is changing both in size and character. Pilot and crew training is a major problem but it is being attacked with the same vigor characteristic of their technical development. Air cadets are offered substantial attractions to enter flight training and the

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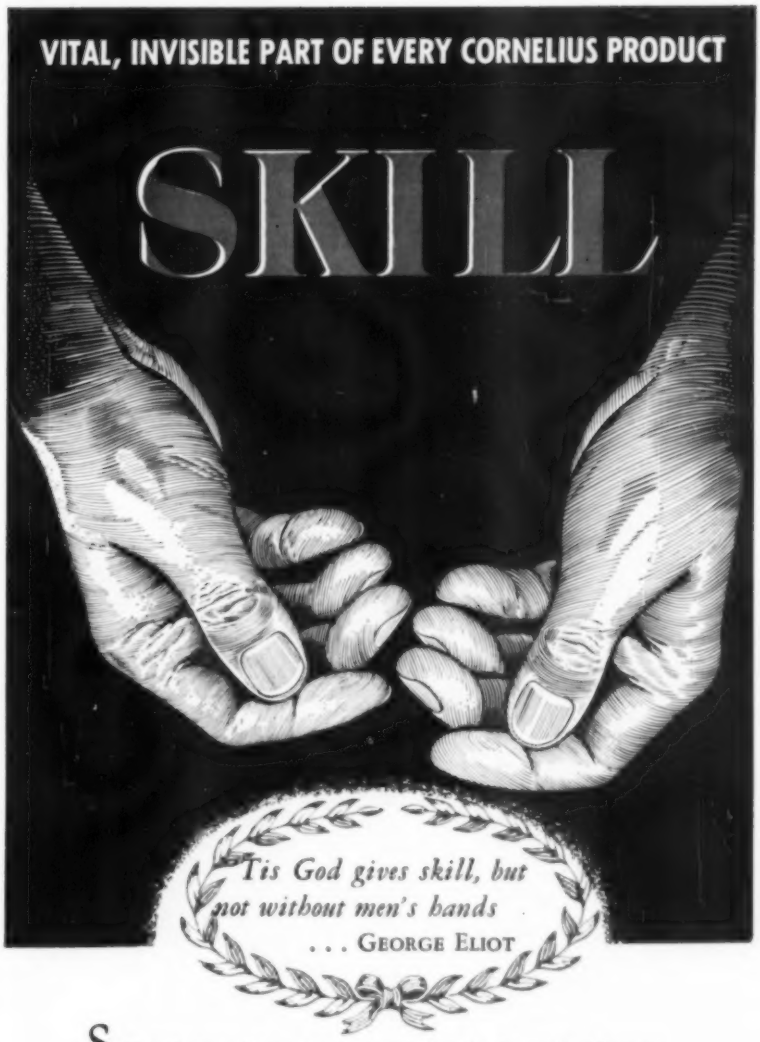

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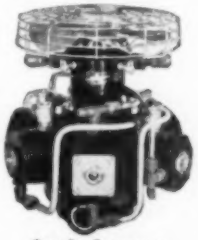

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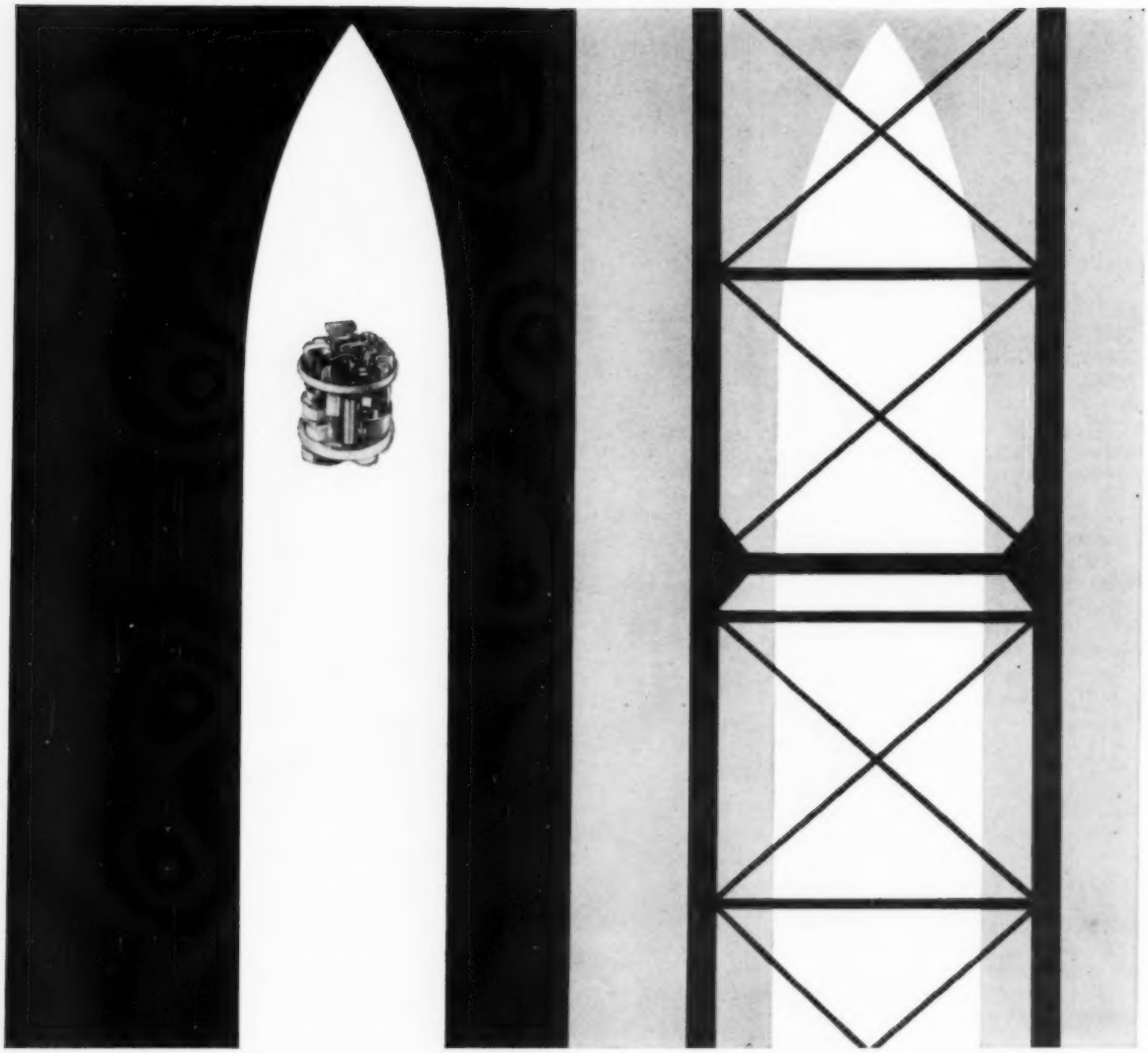

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career of an active pilot in the Russian air force offers many material advantages over civilian life.

The Russian air force also finds itself lacking in both the quantity and quality of air bases necessary for jet operations in the atomic air age. There is conclusive evidence that the Russians are engaged in a major air base construction program including their satellite countries in Europe, in the strategic areas of China and in the Arctic. The Russians have long pioneered Arctic air operations and according to Gen. Twining are now engaged in an effort to operate the year round from a complex of Arctic bases adequate to launch a striking force of hundreds of bombers carrying atomic weapons against the North American targets.

In order to get a true perspective on both the size and pace of the current Russian military air effort it is necessary to look back to 1945.

Soviet Airpower History

With the lessons of American strategic airpower fresh before them in the blasted cities of Germany and the atom-scorched targets of Japan, the Russians made a policy decision to build a jet propelled air force for both defense and offense as soon as possible. Dictator Josef Stalin had long been an advocate of strategic airpower. During World War II he maintained a long-range striking force of four-engine Tupelov bombers under his direct command. This force was never more than 15% operational and was insignificant in the total Russian air effort. But it did illustrate Stalin's deepseated interest in the concept of strategic airpower.

In the 1945-47 period the foundations for this new Russian air force were laid. Although the other major airpowers in the world ended the war with forces far superior to Russia, the advent of the jet engine and the guided missile wiped this slate clean and forced everybody off to a fresh start in the jet and missile era. In this immediate post-war period, while the United States and England were disbanding their air strength and letting their research and development programs dwindle, the Russians began accelerating theirs.

They began, as did the United States and Britain, largely with the fruits of German war-time research.

In addition they had hundreds of German rocket and jet propelled planes and thousands of German aircraft and missile technicians.

Early in 1947 the Russians had their first jet plane in squadron service. It was the Yak-15, which was nothing more than a conversion of the piston powered YAK-9 fighter to jet power with a German Jumo jet engine of about 2,000-lb. thrust.

By mid-1947 the first Russian designed jet fighter appeared in squadron service. This was the MiG-9, equipped with two German BMW jet engines.

Jet Engine Program

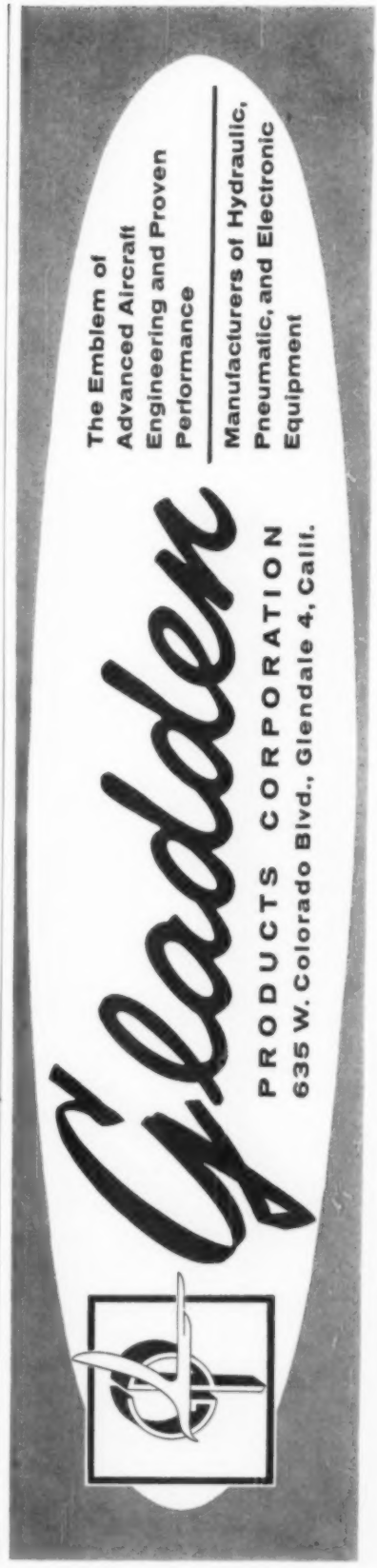
By 1948 the Russian jet program began to gather significant momentum. Russia bought the Rolls-Royce Nene centrifugal flow turbojet from England. Previously all Russian jet effort had been along the German pattern of axial flow design. They built the MiG-15 around a vastly improved version of the Nene and when the Korean war broke out in 1950, the Russians had thousands of MiG-15s in service at the same time that USAF had only a few hundred F-86A Sabres. The MiG-15 and F-86 prototypes made their first flights about the same time in the fall of 1947, so they provide an excellent fix on the relative development cycles and production efforts of Russia and the United States. One of the most startling features of the Russian development during this period was its advance in high temperature metallurgy that not only boosted the thrust of the Nene design over contemporary U. S. and British versions but also solved some turbine blade problems that were still vexing Rolls and Pratt & Whitney engineers.

By 1953 the MiG-15 was being superseded in squadron service by the MiG-17, a modification of the basic MiG design for better performance and using a higher power turbojet. By 1953 the bomber development effort, keyed to the Russians own axial flow turbojet development program was beginning to bear fruit. The Bison and Badger prototypes were built around the new 18,000-20,000-lb. thrust axial flow turbojets and appeared in 1954 to shake some complacency from the western world's superiority complex.

At the same time that this aeronautical development effort was being executed on a scale far greater than that of the U. S., Britain and France combined, the Russians were also pushing a missile program. This has already produced defensive weapons of the Nike type and a 900-mile ballistic missile is in the development testing stage. There are two long-range missile test ranges in Russia—on the Murmansk peninsula in the Arctic and in the Ukraine.

The Russians have also produced atomic and hydrogen weapons. Most recent explosion of a Russian fusion type weapon at an altitude of about 20,000 ft. indicates progress in packaging these mass-destruction weapons comparable to that of the U. S.

By 1956 the Russians had emerged as the second airpower in the world with every indication that they intend to challenge the United States for the lead.



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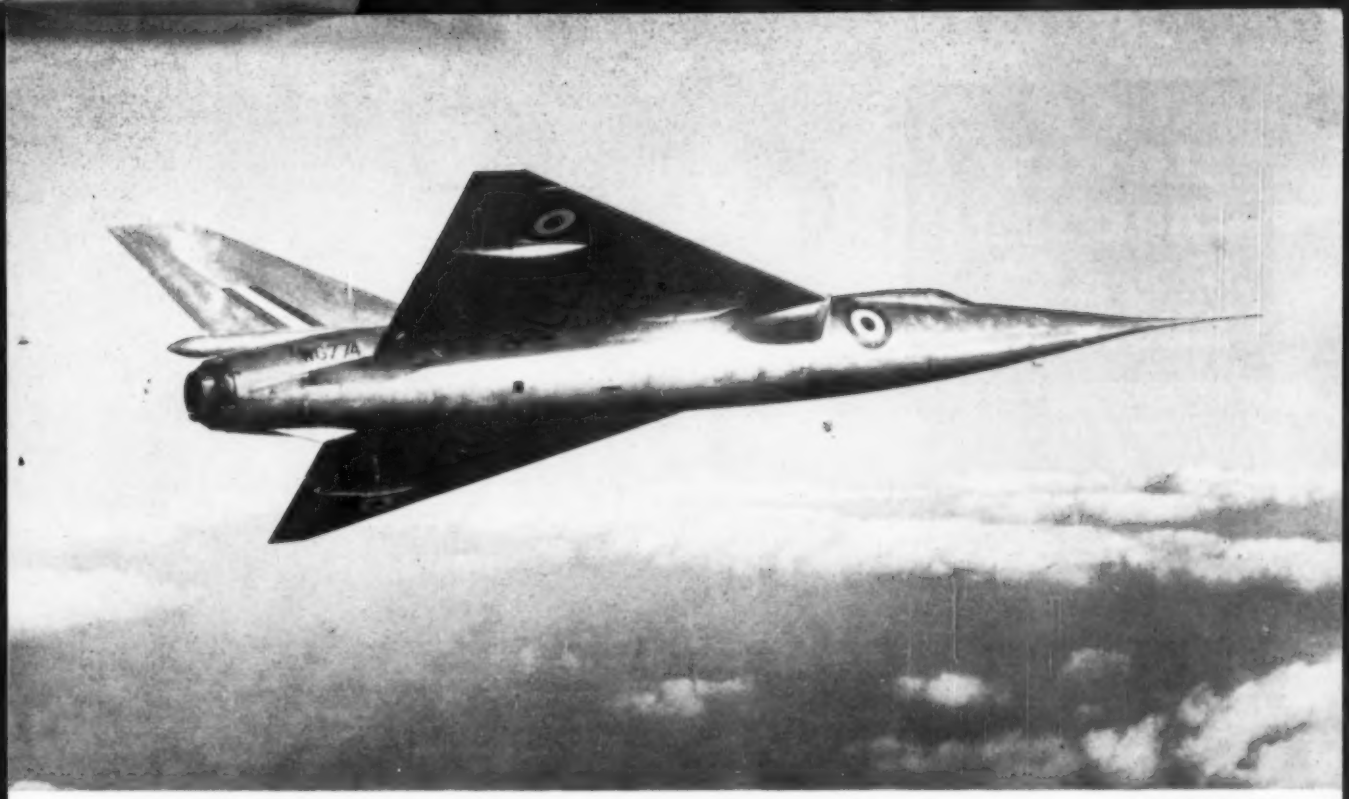

FAIREY DELTA 2

British Airpower Falls Farther Back

LONDON—The Society of British Aircraft Constructors described 1955 as "a year of steady achievement" for the British aircraft industry. It pointed out that exports reached an all time high of $188 million, a $28 million advance over 1954. Government Ministers of Defense and Supply praised the performance of Britain's plane makers and on the surface everything looked rosy. Many other Britons in the know found other words to describe the aeronautical state of their country.

They didn't have to look far to draw comparison, unfavorable comparison, of their country's performance internationally. France burgeoned forth with a galaxy of new and exciting military aircraft and missiles. The U.S. had in being, and in quantity, what in Britain was "just around the corner" that seems to get farther and farther away each year. Even the Russian display of technological advances and productivity seemed to be taken for granted.

A year ago it looked as though Britain might throw off the "boundary layer" of lethargy and indecision which seemed to be retarding progress in the air. Now, the RAF and the Fleet Air Arm are still denied modern aircraft in quantity and a strategic bomber force is little more than politicians' promises. No missiles have come along. The only modern night and all-weather fighters in the country were the F-86Ds of the USAF. Native helicopters failed to materialize.

The civil situation took a decided turn for the worse when the U. S. jetliners burst forth upon the air transport scene.

Yet, there are bright spots here.

• **The engine industry** is maintaining its lead internationally with improved current designs and new engines. To the well tried engines in production have been added small, medium and large turbines offering high power to weight ratios, great development potential and improved economy. New large turboprops of great promise have run. Engines offering novel applications for helicopter power plants have been announced. Rocket motors have been given more prominence.

• **New developments in equipment** particularly include the Dowty runway brake and the Martin-Baker ejector seat modified and live tested to provide safe bailouts from zero feet.

• **Britain overhauled, modernized** and sent to ground the essentials of her early warning and reporting system. Britain is undoubtedly the most completely radar-covered country in the world. Now that her network is tied in with that of Europe, she probably has as much warning, in time, of impending attack as during the Battle of Britain.

The airborne radar and electronic equipment has been disappointing. As a consequence much U.S. equipment is going into Britain's latest night fighters. Personnel to develop and maintain avionic equipment is even shorter.

Industry Fears

Production generally has been at low levels. Behind the façade of last year's Farnborough show—the least exciting since the war—there was genuine concern and fear of retrenchment and cuts at all levels. The spreading round of work and development contracts has been accompanied by strong efforts at foreign sales of military airframes and engines to keep factories going and maintain the labor force of about a quarter of a million.

Despite rumors of a drastic cut in the aircraft industry which was expected to weed out several of the smaller firms, a Conservative (big business) government is unlikely to go this far. More likely is continuation of the trend towards fewer projects.

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were expected to be delivered. They weren't. Many Britons doubt if they ever will be as long as the present system of "nationalized capitalism" prevails in the aircraft industry. They feel that nothing less than a thorough purgative starting at the top will rid the country of its aeronautical constipation and ensure regular production.

Militarily, Britain's air position has improved slightly during 1955. While Britain gets its first swept wing fighters into squadrons, the U.S. and Russia equip theirs with third generation swept wing fighters capable of level supersonic speeds. It will be at least two years before a comparable native British design is ready to go to the RAF.

While Britain forms a couple of squadrons of 68 ton Valiants, American and Russian bombers of 175 tons appear in quantity. Supersonic U.S. Navy fighters and Russian Navy MiGs arm forces of those countries while the Royal Navy musters Sea Venoms and Sea Hawks, neither of which are anything like Mach 0.9 airplanes.

The Supermarine Swift was the first British swept wing fighter to go into service with the RAF. It proved a complete flop. Some 200 have been built. Very quietly the Swifts have been converted to fighter reconnaissance. With altered controls and wings the Swifts as Mark F.R. 5s are expected to replace aging Meteor F.R.9s early in 1956 in Germany.

That leaves the RAF with one new fighter for 1955, the 650-700 mph. Hawker Hunter. Some 600 are now

said to have been produced, with about half that number in actual squadrons in the U.K. and Germany. Its performance is little if any better than the later versions of the F-86 Sabre. With its nearly 50% more thrust the Hunter is undoubtedly a faster and higher climber, with a ceiling in excess of 50,000 ft., though its endurance is likely to be inferior. Several marks are in service—1s, 2s, 3s, 4s, 5s—differing in details and with Avon and Sapphire engines.

The Hunter is not free of its bugs: armament troubles still persist and the fighter has sprouted bulges under its belly to collect the expended links from ammunition belts; engine stalling under firing and maneuvering conditions at altitude has not been entirely eliminated; and several cases of failure of the power control system have occurred—and when this happens control goes to manual.

Several accidents have resulted, as the Hunter in this condition is a large handful for inexperienced pilots.

Recently the makers announced that the Hunter would go to a flying tailplane. The modification won't go as far as a slab tailplane. Rather, a cheap mod involving the replacing of the electric trim actuator by hydraulic motor is likely, with the elevators being tied to the stabilizer as on the F-86E.

A Mark 6 Hunter with a 10,000 lb. thrust Avon engine replacing the present 7,500 lb. Avons and 8,000 lb. Sapphires has been shown as has a two seater side-by-side version.

For the rest of its fighters the RAF depends mainly on Meteors and Venoms for day and night roles.

The Javelin failed to go into service during 1955, but one squadron will be completed in the early part of 1956. An almost unprecedented effort was made to get this plane accepted for service use. Farnborough was called in to carry out an urgent large-scale investigation into the stalling and spinning characteristics of the plane. Then, at the end of the year, an RAF test pilot abandoned the fourth Javelin to be lost.

This big delta winged two seater, of which 50-60 are estimated to have been produced, is Britain's sole hope as a night and all-weather fighter. It is in the 650-700 mph. class and like the Hunter is reported to have a usable Mach number in the lower 9s and a ceiling of over 50,000 feet. With increasing weight this will deteriorate rapidly. To keep up climb and altitude performance, more powerful engines are to be fitted, most likely Sapphire 7s of 10,200 lb. thrust in place of the current 6s of 8,300 lb.

The government has cut back orders for early Javelins, these are to be added to those for an improved airplane.

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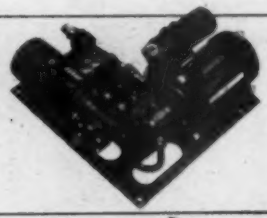
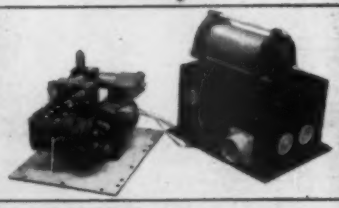
- Maintains a system pressure of 25 P.S.I.A. minimum.
- Motor is .03 H.P.—10,000 R.P.M., 208 V., 3 ph., 400 cy.
- Current draw is .7 amperes/phase maximum under normal operating conditions
- Unit operates continuously
- Weight is 4¾ lbs. maximum



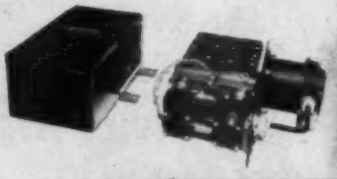
MODEL E AP-150 TYPE 205

- Operating pressure switch maintains a system pressure of 17 P.S.I.A.
- Motor is 1/25 H.P. 7,500 R.P.M., 27 volts D.C. — T.E.B.B.
- Current draw is 2.0 amperes maximum under normal operating conditions
- Life is 500 operating hours
- Weight is 8 lbs. maximum



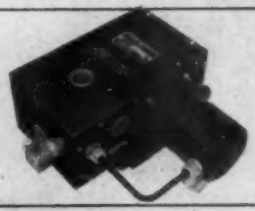
MODEL E AP-1500 TYPE 203

- Operating pressure switch maintains a system pressure of 30 P.S.I.A.
- Motor is 1/15 H.P. nominal 24-28 volts D.C., 5,000 R.P.M., continuous duty, shunt wound
- Current draw is 3.4 amperes maximum under normal operating conditions
- Life is 500 operating hours
- Weight is 12 lbs. maximum



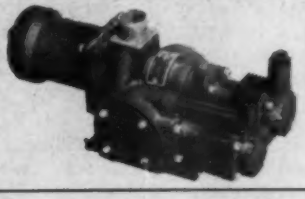
MODEL E AP-2400 TYPE 201B

- Maintains system pressure of 31 P.S.I.A.
- Motor is 1/10 H.P., 24-28 volts D.C., 5,000 R.P.M. continuous duty
- Current draw is 5.5 amperes maximum
- Life is 300 operating hours
- Weight is 10-3/4 lbs. maximum



MODEL E AP-3600 TYPE 200

- Maintains system pressure of 31 P.S.I.A.
- Motor is 1/7 H.P., 10,000 R.P.M. { 208 V., 400 cy., 3 ph. / 24-28 V.D.C. } continuous operation
- Current draw is { 1.3 amp./phase / 7.1 on D.C. } amperes maximum under normal operating conditions
- Life is 1,000 operating hours
- Weight is 8-1/2 lb. maximum



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COMPLETE AVIATION CATALOG #330-P ON REQUEST.

may fly late this year is a much larger airplane with a "thin" wing and two Bristol Olympus engines which may go up to 18,000 pounds thrust.

Two prototypes of the English Electric P.1 have flown. The aeroplane is reported to be doing very well. However, it is two years or more from service. Performancewise, it is likely to be in the category when developed of the Crusader or present F-104.

Dual Power Fighters

The big trend in fighters is towards interceptors employing combined jet and rocket power. Shortly due to fly is the Saunders Roe S.R.53 which has won government support over the Avro 720. Similar projects are also underway at Hawker and at de Havilland, the latter firm coupling its Gyron engine and Spectre jet to fulfill the mixed formula.

Backbone of RAF bomber strength remains the English Electric Canberra.

Bomber Command also has three squadrons of Vickers Valiant medium bombers; about 60 of these aircraft are in existence and a great deal of ironing out on their equipment side still remains. Performance would seem to be but little faster than a B-47.

Neither the Avro Vulcan nor the Handley Page Victor reached service in 1955.

The tailless delta Vulcan quietly sprouted an altered wing plan. The reason given: "to take advantage of engine of greater power coming along." More probable reasons: to improve stability and damping at altitude.

Last, and by all reports far and away the best of Britain's bombers, is the crescent winged Handley Page Victor. This weird looking aircraft has the best altitude and Mach number characteristics of the lot, reputedly getting very close to Mach 1 at altitude. Production is somewhat behind that of the Vulcan.

The RAF now uses a piston engined Provost, jet Vampire trainer sequence for its flyers. During the year a small batch of jet Provosts (Armstrong Siddeley Viper engine) were used experimentally for primary jet training. Reported as having been successful, this may be the forerunner of all-jet training for future pilots.

Twenty-four large Blackburn Beverleys have been put on order for cargo carriers, and the first Comet 2 for Transport Command flew in RAF colors.

Weak in modern equipment, the RAF also is weak in manpower of the kind it requires. Quality aircrews are not coming forward in anything like sufficient numbers. The service suffers from a serious shortage of skilled technicians, particularly in the electrical and radar electronics trades.

The air arm of the Royal Navy is, if anything, worse equipped than the

RAF. It does not boast one single swept wing aircraft in service and it too has its manpower problems. Formerly a volunteer service as far as its flying personnel were concerned, it is now "appointing" aircrew from its non flying branches—"press-ganging" it has been called by the press.

The R.N. has two standard fighters in service:

• **The 600 mph. straight-wing** Hawker Sea Hawk with a 5,000 lb. thrust Rolls-Royce Nene engine is the day fighter.

• **For night and all-weather** the D.H. Sea Venom, powered by a 5,000 lb. D.H. Ghost engine is the plane.

Neither has full power operated controls and limiting Mach number is about .85.

The Navy's strike aircraft is the turboprop Westland Wyvern, a heavy single seater in the 450 mph. class.

Several squadrons of 350 mph. Fairey Gannets went into service in anti-submarine and reconnaissance roles.

Fleet Air's Future

For the future, the Fleet Air Arm will rely on a navalized version of the D.H. 110 for its all-weather fighter and the Supermarine N. 113 for its day fighter. The latter should do around Mach 1.2 level. The Navy has made great play of the fact that the 113 and the 110 will carry guided missiles. The N. 113 had a flying tailplane from the start, a saw-tooth leading edge to its swept wings and blown flaps to improve takeoff and landing. Boundary layer control over the ailerons is also said to be used to complement the flap system and improve low speed handling. Squadrons are not likely to see it till 1958.

The Navy recently canceled its order for the twin-engined, twin-rotor, Bristol 191, a development of the 13-16 seater 173. The RAF is to take this helicopter while the Navy has announced that it will have Sikorsky S-58s, which will almost certainly be built in Britain by Westlands.

The British Army has taken very little part in aviation, and there is not much likelihood that the RAF will allow this situation to change. The Army has kept extremely quiet and has so far expressed few ideas of what it wants if indeed it knows. Certainly, there has been none of the outspoken plans for an Army Air Corps which has enlivened the American scene.

V-1000 Cancellation

One major shake-up provided in British civil aviation was the government decision to withdraw its support from the Vickers 1000 jet transport and its civil version the V.C. 7. This large jet was looked upon as the successor to the Comet. With four Rolls-Royce Conway by-pass engines of 13-18,000

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THE 1200 SERIES was designed to meet the requirements for greater flow than the 1700 Series. The displacement of the smallest pump in this series is 0.0154 cubic inches per revolution. The largest pump has a displacement of 0.0768 cubic inches per revolution. This series operates satisfactorily between a temperature range of —65°F to +160°F. They handle pressures as high as 1,000 p.s.i. and can be driven at speeds up to 6,000 R.P.M.

THE 1100 SERIES has similar performance characteristics to the 1700 Series. The displacement of the smallest pump in this series is 0.00838 cubic inches per revolution.
1101-5 is flange-mounted pump. *1102-10R* is specially constructed of corrosion resistant materials; bronze housing, bronze gears, monel shafts, carbon bushings and synthetic rubber seals, designed to handle degreasing liquid.

THE 1400 SERIES Pumps are multi-element units of minimum weight and size designed to perform satisfactorily under severe conditions of low temperature and high altitude. These pumps have an aluminum housing, steel gears and shafts, synthetic rubber seals, and carbon bearings. The multi-element pumps are designed to meet requirements for scavenging and lubricating.

THE AR SERIES are commonly used as emergency stand-by fuel pumps. Motors are 1/50 H.P. aircraft type, 4500 R.P.M., available for 12 or 24 volt D.C. Size 6" x 4-3/8" x 2-3/8". Weight is approximately 2-1/4 lbs. Pumps are constructed of aluminum, and have mechanical rotary seals.

THE 100 SERIES is a continuation of the 1200 Series for still greater flow requirements. The displacement of the smallest pump in this series is 0.104 cubic inches per revolution. The largest pump in this series has a displacement of 0.365 cubic inches per revolution. Operates between a temperature range of —65°F. to +160°F. and pressures up to 1800 p.s.i.g.; speeds up to 3450 R.P.M.

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Write for Aviation Products Bulletin 330.

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lb. thrust buried in the wing roots, the 250,000 lb. plane was expected to carry up to 150 passengers non-stop across the North Atlantic at 550 mph.

To charges that the prize North Atlantic route was being abandoned to the U.S. jets, both the government and BOAC replied that they placed their confidence in the long-range versions of the Bristol Britannia.

Britannia Hopes

Though never liable to be sprint champions for long, the 360 mph. Britannias (one a 54-seat 1st class plane, the other a 90-seater tourist version) are impressive with their silence, steadiness, spaciousness and feeling of comfort. Serviceability and route bugs may well lie dormant but the general belief is that the Britannia will be a good home-produced work horse in the international class.

Current orders for the Britannia total 49, all inside the U.K., except four to Canadian Pacific and three to El Al. BOAC also finds itself the only operator so far of Comet 4s with an order for 20. This is hardly likely to make the Comet 4 an economic plane to produce.

Viscount Success

The turbo-propeller Vickers Viscount continued its excellent record as Britain's most successful airliner—the only one ever to break successfully into the U.S. domestic market. During the year orders increased to 274. Capital in the U.S. put its first Viscounts into service and Continental Airlines placed an order for 12 of the bigger and faster 800 series for delivery in 1958.

Even so, it is felt that Vickers wasn't big enough or bold enough to seize the golden opportunity their world lead in turboprops gave them. Had better deliveries been offered, it is quite probable that few Convairs would have been sold in the past few years and that orders might have been doubled.

Later versions of this series, such as are on order for Continental, will go up to 65,000 lb. and 2,100 hp. R.Da.7 Darts will raise the cruising speed to 363 mph. Further development by Rolls-Royce is slated to bring the power of the Dart up to 2,500 hp. for takeoff. This is the R.Da.8 engine and it is expected to give the Viscounts cruising speeds up to 400 mph. and allow 68,000 lb. maximum all-up weights.

Vickers Vanguard

Vickers announced another entirely new airplane. It too is a turbo-propeller airliner, 20 of which have been ordered by BEA for delivery commencing 1959-60. The Vanguard will carry 93 passengers in a double-bubble fuselage. Four Rolls-Royce RB. 109 Tyne engines of around 4,500 hp. promise

425 mph. cruising speeds for the 120,000 lb., 2,000 mi. range plane.

Many aeronautical experts in Britain feel that this plane is too close to the Lockheed Electra which is promised two years earlier.

Handley Page got its Herald into the air in time for Farnborough and has announced the laying down of a production line for 100, hoping that the aircraft will be a DC-3 replacement.

Out to cash in on the undeveloped aerodrome market is the Scottish Aviation Twin Pioneer dubbed the "Double-Scotch."

Gyron Growth

Biggest of the new British engines shown for the first time in 1955 is the de Havilland Gyron. It has been running since 1953 and flying in a Short Sperrin (bomber test bed) since last July. It is a stubby looking engine of great external cleanliness, diameter 46¼ inches, length 154 inches. An initial thrust rating of 15,000 lb. has been announced and it passed its 150-hr. type test at this rating. This engine should be capable of 22,000 lb. The Gyron appears to be straightforward: single spool compressor, multi-stage turbines and an annular combustion chamber.

A scaled down version, known as the Gyron Junior, running since mid-summer, can be expected to start out at around 7,500 lb. thrust, working up to 10,000.

The de Havilland Super Sprite is a 620 lb. unit, 20¼ inches in diameter and 117¼ inches long. It burns hydrogen peroxide and kerosene or petrol to give 4,200 lb. thrust for 40 sec. Its main use is as a takeoff booster for V class bombers. It can be either a fixture or jettisonable. For fighter use as a booster, D.H. has the Spectre, also a liquid fuel rocket. It is understood to be throttleable and to give around 6,000 lb. thrust.

Second most powerful engine to be announced is the Rolls-Royce Conway by-pass engine which has been type tested at 13,000 lb. thrust. Specifically designed to go into the Vickers 1000 jet transport, it has a potential 18,000 lb. thrust with exceptional fuel economy and low noise, by virtue of the fact that the intake air, passed around the combustion chamber rather than through it, produces a lower velocity efflux than a straight jet. The Conway now has no home although Douglas offers it in the DC-8. It may be installed in the Victor bomber and in a podded successor to the de Havilland Comet.

Rolls-Royce is progressively improving power and overhaul life (now at 1,200 hours) of the Dart. To follow it is the RB. 109 Tyne. In the 4-5,000 hp. class it has been running on the

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test bed for some time. Approximate weight and dimensions are 1,950 pounds, diameter 32 in., length 115 in., specific consumption 0.4.

Bristol two spool Olympus engines recently took a Canberra to a new world's altitude record of over 65,890 ft. Type-tested at 11,000 lbs., it has been reported that the engine will develop up to around 20,000 lb.

The Orpheus completed a type test during the year at 3,280 lb. thrust and in midsummer flew in the Folland Gnat. It has been accepted as the engine to power the Fiat G-91 light fighter. Thrust of 4,850 lbs. is expected eventually and this may rise to 7,000 with afterburner.

Bristol ran its BE.25 "supercharged" turboprop engine for the first time last year. This is a twin spool design with annular combustion chamber and four stages of turbines. It maintains its full sea level power up to 20,000 ft. and is reported to give over 4,000 hp. for cruising at over 30,000 ft. This is the engine for the thin-wing Super Britannia. Dimensions: diameter 41¼ in., length 110¼ in., specific fuel consumption .385.

One of Britain's most successful jet engines is the Armstrong Siddeley Sapphire fitted to the Hunter, Javelin, Victor and supersonic P.1 prototypes. Latest is the Sa7 which is type tested and in production at 10,200 lb. An Sa9 is reported to be in the 14,000 lb. class.

This company's rocket motors have flown experimentally in a prototype of the Hawker Sea Hawk and in a Meteor. The early Snarler employed liquid oxygen and water-methanol as fuel, but the newer Screamer is thought to use kerosene and liquid oxygen and to be a fighter booster engine of vastly more power than the old 2,000 lb. thrust Snarler.

Eland Turboprop

Napier extended flight trials of its Eland turboprop from a Vickers Varsity to an Airspeed Ambassador in 1955.

Early this year a Convair 240 flew on these engines. Current Elands give 3,000 hp. but a 4,200 hp. version is now running with air cooled turbine blading. This engine has been specified as an alternative power plant for the Lockheed Electra. Napiers are also hopeful that their Convair trials will enable them to sell conversion kits to Convair operators.

Napier is going after the helicopter turbine market with a range down from 3,000 hp. Eland through the 750 gas hp. Oryx to the 1,250 shaft hp. Gazelle.

Lack of basic research and the inability to act or think big has largely accounted for the decline of the British aircraft industry. There has been no

lack of men with ideas or the ideas themselves. There has been no lack of adventurous men of wisdom nor has their been a lack of brave men to fly new creations.

There have not been bold top decisions, ruthless getting rid of the masses of dead-heads grimly hanging on to their positions, and drive to develop ideas and to produce. Good ideas have been doomed by faint-heartedness, lack of the essential knowledge which only comes from research and lack of modern engineering techniques, tools and materials. These have limited designs.

Despite huge groups and firms, Britain has no one facility capable of producing large aeroplanes in quantity. By U. S. standards the great combines are little more than associations of backyard garage operators. Their equipment is equally lacking so that planes are still made and designed much as were their excellent predecessors of 15 years ago. Milled skins, taper rolled skins, honeycomb sandwich construction are only now making an appearance in prototypes or pre-production aircraft.

Only now are tunnels with supersonic capabilities beginning to appear in any number whereas present aircraft going into service should have had detailed benefit of the knowledge they could have provided.

Missile Doldrums

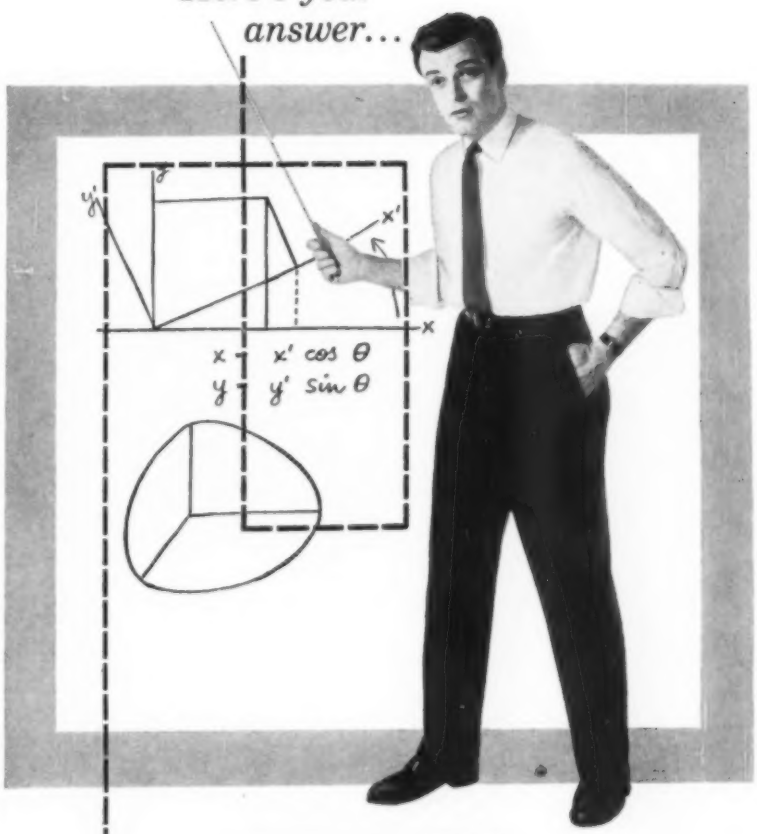
Grave concern has also been expressed in Britain by lack of progress with guided missiles, none of which have yet appeared in service. Projects were recently cut from 15 to four in an effort to get something moving.

Talk of something bigger and better and faster than the Boeing and Douglas jet liners falls deafly on "knowledgeable" ears. One doesn't build supersonic airliners and, especially, one doesn't without vast knowledge acquired over a long period with fighters and possibly bombers.

More in the immediate future, the things to watch for are: rocket and rocket-with-jet fighters; further developments of sucking and blowing and boundary layer control; deflected jets akin to the jet-lift Meteor which carried excessively powerful engines and during landing ducted part of the jet downwards to off-load the wings; and a more practical example of the Rolls-Royce "Flying Bedstead" principle probably in the form of multiple Soar engines mounted to exhaust downward from a current airframe such as a Meteor or Canberra.

Britain stands little likelihood of regaining her past position of aeronautical greatness until another Lord Beaverbrook takes over to "axe a few heads" and "kick a number of backsides." So far there does not seem the remotest chance of that happening.

Here's your answer...



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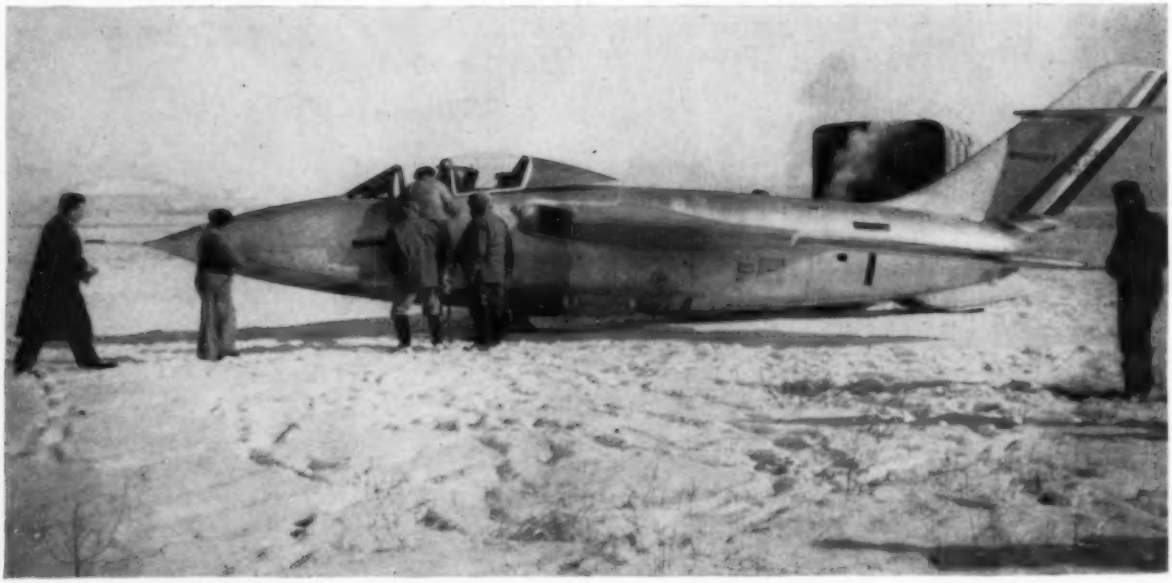


SNCASE SE-5000 BAROUDEUR

Budget Slows French Airpower Build Up

PARIS—Still severely hampered by an inadequate budget, the French air force spent the past year gradually replacing outmoded equipment and expanding its training program. On paper, the 37 squadrons in being at the end of 1954 grew to 41 at the end of 1955, but total aircraft of all types remained steady at about 2,250 units.

The French aircraft industry, prolific producer of protoypes during the past several years, was manufacturing several tried planes of modern and competitive design. For the first time since the war profitable export markets were opening, particularly in Latin America and the Middle East, for Dassault's Mystere, the Sncaso Vautour, Sncase's medium-range jet transport Caravelle, the Morane-Saulnier Paris and the Fouga Magister. Exports may well overcome the industry's most serious deficiency—insufficient production runs, which result in high unit prices.

SNCASO SO-1221 DJINN

In addition to delivery under the Mutual Defense Assistance Program of F-84Fs for two combat and one reconnaissance squadron during 1955, the French air force received 80 Dassault Mystere IV-As and 65 Mystere II-Cs, to equip new squadrons and to begin the replacement of Ouragans and older F-84 versions.

The Mystere IV-A, powered by a Verdon engine of 7,700 pounds thrust (produced by Hispano-Suiza under Rolls-Royce license), has a top speed of 700 mph., carries two 30-mm. cannon and rockets. With the F-84F, it will provide the backbone of the FAF for some time to come. An additional 250 Mysteres are on order and will be delivered during 1956 and 1957. The last 70 Mystere II-Cs, a somewhat slower version with a Snecma Atar 101-D-1 engine of 6,600 pounds thrust, will be delivered in 1956.

Super Mystere

Production of the Super Mystere, last of the swept-wing versions of the Mystere group, will follow. Also powered by a Rolls-Royce engine, made by Hispano-Suiza, the Super Mystere is supersonic. It flew last March. Two hundred have been ordered. Production models will be equipped with the Snecma Atar 101-G-21, 9,240 pounds thrust with afterburner.

Looking further ahead, the French will have the Vautour in production in 1957. Built by Societe Nationale de Constructions Aeronautiques du Sud-

SNCASO SO-6050 VAUTOUR

Ouest, prototypes of the Vautour have been developed in three versions: attack, fighter-bomber and night-fighter. At present the Vautour uses a Sneema Atar engine developing 7,700 pounds thrust and achieves supersonic speeds. Bomber and night-fighter versions are two-place. Initial order is 140, with delivery scheduled for the first half of 1957. The Vautour has been thoroughly tested and praised by American test pilots.

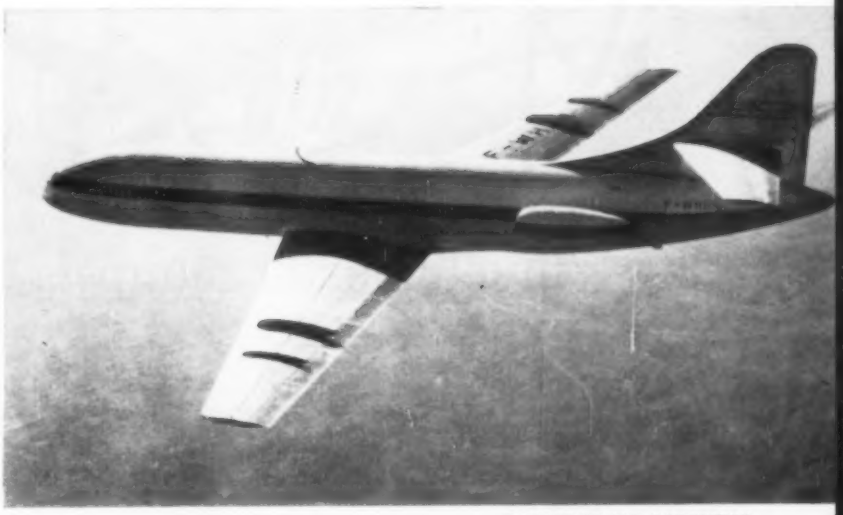
Bomber Command

Arrival of the Vautour will mark the reactivation of a French bombing command, non-existent since the war. The command organization was formed during 1955 and a training center established.

Two delta interceptors, the Dassault 550 and the Sncase SE-212, are in prototype stages. The Dassault flew for the first time in May, 1955, with two Viper engines produced by Dassault under Armstrong Siddeley license. The first prototype was handed over to the government Flight Test Center in January. The French government is considering an order of 150.

The 212, named the Durandal, was expected to fly for the first time in February or March. The prototype uses an Atar G Vulcain engine developed by Societe Nationale d'Etudes et de Construction de Moteurs d'Aviation.

The Sncase SE-5000 Baroudeur, experimental interceptor which uses a dolly to permit short takeoff, appears



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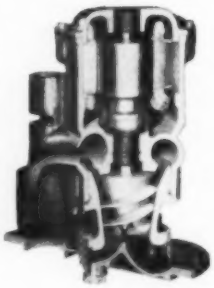

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to have been dropped from French plans, but the industry continues work with several other experimental planes. The ramjet Leduc tests are continuing and a Leduc 0.22 is under construction. The Sud-Ouest 9050 Trident, equipped with two Dassault-built Armstrong Siddeley Viper engines and an SEPR rocket motor, reportedly has exceeded 1,100 mph. in level flight. One of the two Trident prototypes crashed and was badly damaged in early January. Blame is put on fuel-pump failure, but the investigation is not complete.

Breguet is building two versions of its lightweight Taon fighter. Developed under the NATO program for small fighter research, Taon is a single-engine version and will be known as the Breguet 1001. The French Air Force is financing a twin-engine type, numbered 1100.

In the field of military trainers, Fouga received an order for 95 of its 170R Magister. This plane also will be built under license in Germany by Messerschmitt. It uses two Turbomeca Marbore II engines of 880 pounds thrust and flies at 450 mph.

Morane-Saulnier has received a tooling order for its MS-760 Paris and expects a contract within six months for 50 units from the French Air Force and 30 for the Navy. The Paris will be made in America by Beech under license.

The French Air Force began a long-needed modernization of its transport and troop-carrying equipment. Sncan has delivered 90 of 160 Nord 2501s with a 14,300 lb. payload. It will carry 42 passengers and a crew of three. It has a cruising speed of 210 mph. and a range of more than 1,500 mi. A modified Nord 2506 uses two supplementary Marbore II jet engines which increase both range and speed.

The FAF has ordered 15 Breguet Deux Ponts and has taken over three prototypes for training. The military version will be known as the 765 (the commercial version, the 763 or Provence, is in use on Air France runs to North Africa).

Missile Effort

Considerable French effort has been put into the development of rockets and guided missiles, but results indicate nothing of greatly advanced design or performance. Two air-to-air weapons, the Matra R.051 and the Sfecmas 5103, have been ordered by the FAF. The first weighs 420 pounds, the second 285 pounds; both are equipped with proximity fuses and are guided in flight. Both are said to be highly accurate at medium ranges.

Ground-to-air missiles are entirely at the developmental and testing stage. The SE-4300, said to be comparable to the Nike has a take-off weight of

one metric ton and a span of 11.1 ft. More promising is the Parca developed by the Direction des Etudes et Fabrications d'Armement, with a span of 5.2 feet and a takeoff weight of one metric ton. Present experimental version is said to be effective up to more than 30,000 ft. Both missiles are radio-controlled.

Tests on a scientific rocket, the Veronique, are continuing at a range near Colomb-Bechar, Morocco. The present version of the Veronique has reached a height of 83 miles. It develops a total of 70,000 horsepower during its 40 seconds of powered flight. Used entirely for scientific purposes, it can lift up to 220 lb. of instruments into the ionosphere. The instruments are released by timed explosions, and their parachutes open at 10,000 feet.

Navy Air Arm

The French Navy's air arm, severely restricted by budget during 1955, ordered fifteen SE Aquilon carrier-based interceptors. The Aquilon is a modification of the British Sea Venom powered by a de Havilland Ghost engine of 4,840 pounds thrust. A total of 90 have been ordered from Sncase, of which 50 have now been delivered.

France has two gas turbine helicopters in series production. The Sncaso Djinn utilizes a Turbomeca Palouste developing 528 lb. thrust to provide compressed hot air to a two-blade rotor with ejection nozzles at each blade tip. With a 36-foot rotor, the Djinn has a maximum payload of 949 lb. and an operating speed of 40 to 70 mph. Its maximum endurance is two hours and 15 minutes. Military orders now total 100; 15 units had been delivered by the end of 1955.

The larger Alouette (SE-3130) produced by Sncase made its first flight during 1955 and established an altitude record of 26,932 feet. It is powered by a 400 hp. Turbomeca Artouste II gas turbine which drives its lifting rotor and anti-torque rotor mechanically. Normal payload is 1,300 lb. Cruising speed is 92 mph., and maximum flight endurance is four hours. Army, Navy and Air Force orders total 180. Sncase has announced first civilian sale to Electricite de France.

Caravelle Prospect

In the field of civil aviation, interest centers on the Sncase SE-210 Caravelle. The prototype of France's first jet transport flew in May and has now completed 250 hours of trial flight. Equipped with two 10,500 pound-thrust Rolls-Royce Avon R.A.29 engines, the new medium-range transport will carry 70 passengers at a cruising speed of 475 mph. Normal payload is 15,400 pounds with a maximum range

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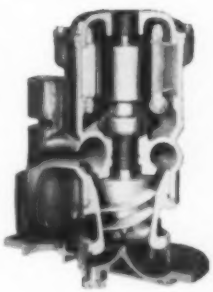

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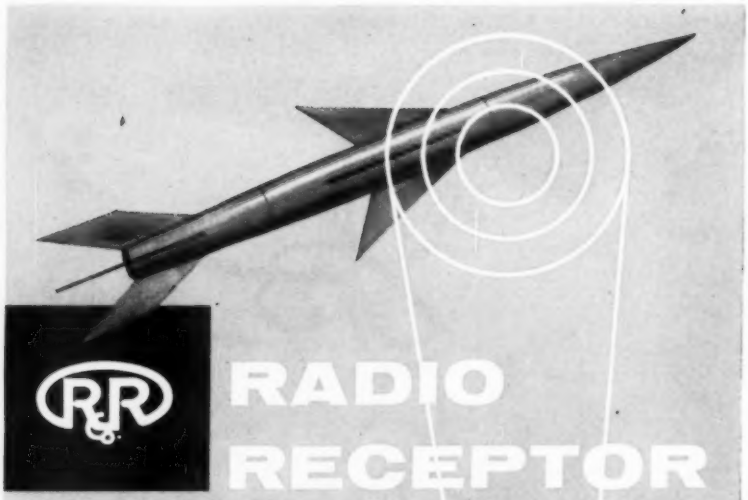

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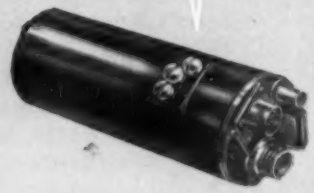
One of RRco.'s latest projects is the design, development and manufacture of the subminiature S-Band Missile Beacon for the Army. This transistorized unit 6" long by 2⅛" in diameter provides communication facilities which permit tracking and guidance of the missile in flight.



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of 1,850 miles. Air France has ordered 12 of these aircraft for delivery beginning in 1958. Negotiations are underway with the Australian government; according to French industry sources, a contract is likely to be completed for several by Australian domestic airlines. Georges Hereil, director of Sncase, has recently announced that the Caravelle will be displayed in the U. S. in 1957.

Sales difficulties have been encountered by Hurel-Dubois in marketing its HD-32, high-wing replacement for the DC-3. Air France initially agreed to take 24 HD-32s, but recently reduced its order to seven. Without other orders, Sncase has refused to tool up to produce the plane for Hurel-Dubois.

A civilian version of the Nord 2501 Noratlas is reportedly under consideration by French private airlines. Union Aeromaritime de Transport, operating mainly in Africa, is currently using this plane modified with two Marbore II jet engines on the outer wing sections to assist on takeoff. Main power plant is two Hercules engines of 2050 hp.

Boisavia's new Anjou, a five-passenger tourist plane using two Sneema reciprocating engines, has made test flights and is likely to become France's most popular light plane. Finally, the SIPA 1000 Coccinelle, tiny two-seater powered by a Continental engine, is undergoing modification before starting series production. Price on the Coccinelle will be about $1,100.

Industry Status

Although representatives of the French aircraft construction industry seem to believe that the industry is at last finding itself on a more solid base after several years of frantic search for modern and effective models, overall figures for the industry do not yet reflect this change. Employment remained unchanged at 60,000 during 1955 with 28,000 in nationalized sections of the industry (Sncaso, Sncase, Sncan and Sfecmas), 15,000 in private airframe and engine companies, and 17,000 in private equipment companies.

Based on the first eleven months of the year, output for 1955 totaled approximately 330 aircraft with a total airframe weight of 1,585,000 pounds. This compares with 360 aircraft and 2,033,000 pounds of airframe weight in 1954. Engine production in 1955 is estimated at 832 against 780 in 1954. Total horsepower of the 1955 engine output was about 2,620,000 against 2,412,000 in 1954.

With the development of the delta 550, coming after a long series of various versions of the Mystere and the Ouragan, Societe des Avions Marcel Dassault (newly renamed La Generale Aeronautique Marcel Dassault) has established itself as a major force in

French aircraft industry. The company employs 4,000 people directly in its six plants, but indirectly is responsible for 20,000 workers, one-third of the entire industry in France, through its subcontracting operations, particularly with Sncase and Sncaso.

Dassault is spreading its coverage. It now has an engine department, making the MD-30 Viper under license from Armstrong Siddeley Motors Ltd. It also acquired production rights for the Swarthout line of electronic testing and control equipment.

Although Sncaso with 5,000 employes is smaller than its fellow-nationalized Sncase (9,200 employes) its immediate prospects look brighter. The Vautour is a predictable backbone for the French Air Force during the period 1957-1959, and in the experimental Trident, Sud-Ouest may have the next stage of piloted interception.

Sncase, however, is developing guided missiles which remain entirely on the secret list while the bulk of its facilities are engaged in producing components and airframes for the Dassault Mystere and the Fouga Magister. With the Alouette helicopter an apparent success and a good outlook for the Caravelle jet transport, Sncase prospects also are good.

Breguet Troubles

Breguet, seriously in debt as a result of steady losses over several years, was reorganized in 1955. With a new order from the FAF for the Deux Ponts and with several experimental planes underway (notably the Taon), and backed by fresh capital, Breguet will try for a comeback.

Turbomeca remains an outstanding producer of small jet engines (licensed in the United States by Continental). Its Marbore II (880 lb. thrust) has found a wide range of uses as a supplementary engine on various aircraft and is being used in target missiles. The Artouste and Palouste have found a place with the two French helicopters now entering production.

More than half of France's engine industry is represented by the nationalized Snecma, developers of the Atar series of gas turbine engines, the largest of which will be used on the Vautour series. Latest developments on this engine are sufficiently encouraging to permit hope that France is overcoming its lag in larger jet-engine research.

In general, the French aircraft industry expects an increase in production and employment in 1956 and 1957, based largely on an increase in export orders for proved models now available. A limited military budget will provide early upper limits to such expansion. Even so, the industry is considerably more optimistic than it was a year ago.

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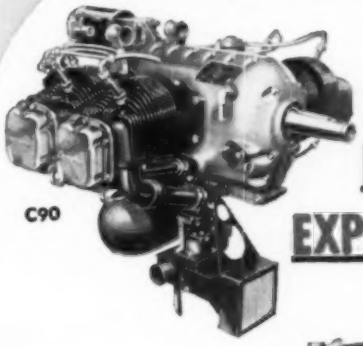

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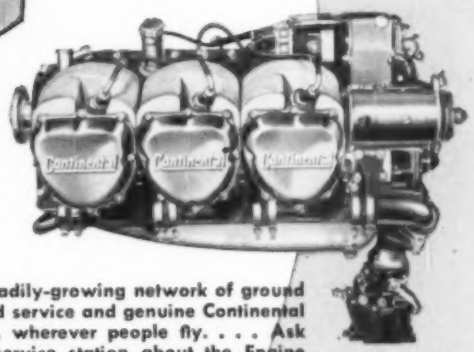

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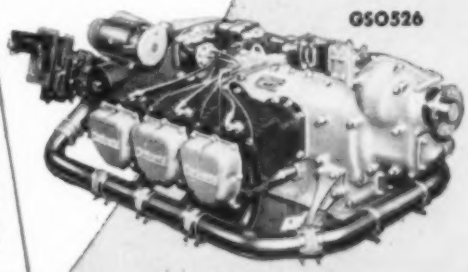

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For example, the starting, generating and ignition systems used on reciprocating engines were not applicable on jets. One of our new Bendix jet starters, small enough to put in a breadbox, produces 450 h.p. to crank a giant jet engine 1800 r.p.m. in three and a half seconds.

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Including receivers, transmitters, flush antennae, radio compass, radio magnetic indicators, marker receivers, glide slope receivers, VOR-localizer receivers, Omni-mag indicators, cockpit loud speaker, distance measuring equipment, transponder beacon and selective calling, passenger address and transistorized interphone systems.

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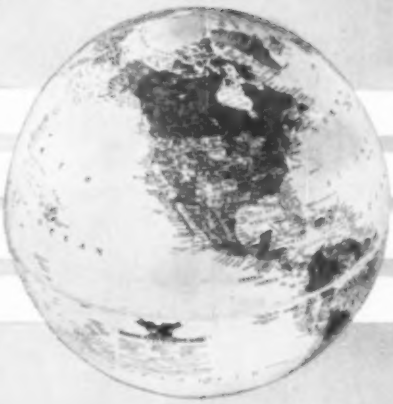

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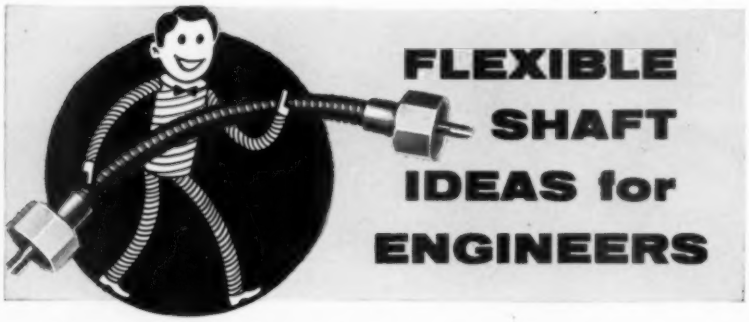

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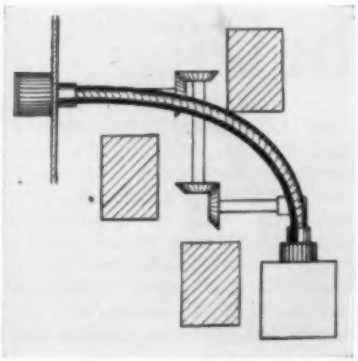

One flexible shaft is all it takes to do a job that might otherwise require an entire system of bevel gears, straight shafts, universals, etc. Added to this is the fact that installation is greatly simplified and alignment problems are eliminated.

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New Aircraft

TORONTO – Canada's airpower continues to grow in the factories and in the air.

New, faster, more heavily armed and higher-flying fighter aircraft are now coming off production lines in eastern Canadian factories, and being supplied in a steady stream to Royal Canadian Air Force squadrons at home and in Europe.

Still faster aircraft are now nearing the production stage and are expected off the production line by the fall of 1957.

The RCAF Air Defense Command at St. Hubert, Quebec, just outside Montreal, is in constant instantaneous touch with USAF Air Defense Command at Colorado Springs, Colo. The three lines of northern radar warning networks and the planned East and West Coast networks are part of close Canadian-United States cooperation.

Canada's North Atlantic Treaty Organization commitments include not only the establishment of RCAF squadrons in Europe but the aircrew training of nationals of 10 NATO countries.

Defense Budget

In the 1956-57 fiscal year starting Apr. 1, Canada will spend on defense $1,775 million, or 40% of the national budget. This is about the same amount as was spent in the last fiscal year.

Included in the estimate is $197 million for aircraft and engines for the RCAF–$100 million less than in the past fiscal year because "the air force is essentially equipped now," according to government officials. The RCAF share of the estimates include $99 million for construction, up $30 million over the last year, and $11 million more for radar and electronics systems than in the past year, raising the figure to $45 million.

The Defense Research Board has a $79 million estimate for 1956-57, almost a third more than in the previous year, much of it for "the new family of aircraft." A specific item of aircraft development expenditure is $1,750,000 for a start on a supersonic wind tunnel.

For NATO, the estimate for mutual aid is down in total, but the amount for aircraft and engines is up by $12 million to $43 million.

The RCAF today has a strength of just under 51,000 officers and men, the maximum set for this year.

All-Weather Squadrons

The RCAF has nine squadrons flying all-weather jet interceptor CF-100 air-

Bolster Canada's Continental Defense Role

craft in Canada from the Atlantic to the Pacific. They are operating with Mark 4 aircraft as part of the Pine Tree early warning radar network, the most southern of the three radar nets strung across Canada. In the coming year they will get the Mark 5 version of this Canadian-built aircraft. The Mark 5 has an operational ceiling of 50,000 feet, 5,000 feet more than the Mark 4.

The RCAF will spend $150 million replacing the CF-100 Mark 4 with the Mark 5. About 300 of the new aircraft have been ordered from Avro Aircraft Ltd., Toronto, which will produce about 10 a month.

NATO Forces

The RCAF maintains 12 fighter squadrons in France and Germany. These are equipped with the Canadian-built Sabre 5 and the Sabre 6, both powered by the Canadian-built Orenda 14 jet engine. Canada's air division overseas is part of the Fourth Allied Tactical Air Force.

Bases have been built at Grostenquin and Marville, France, and at Zweibruecken and Baden-Soellingen in Western Germany.

In Canada, the RCAF operates a Maritime Air Command with headquarters at Halifax, and squadrons on both the Atlantic and Pacific coasts. They work closely with the Royal Canadian Navy and NATO Atlantic headquarters at Norfolk, Va.

The job of the Maritime Air Command planes includes anti-submarine warfare, reconnaissance and convoy patrols. They are equipped with modified long-range World War II Lancaster aircraft and recently acquired United States-built Lockheed P2V-7 Neptune aircraft.

Plans are underway for replacement of the Lancaster aircraft with a modified version of the British Bristol Britannia, now being built at Canadair Ltd., Montreal, for delivery in 1957.

Transport Command

The RCAF Air Transport Command has its headquarters at Lachine, near Montreal, and uses a variety of aircraft, including Canadian-built DC-4 North Stars, Dakotas, C-119s, Beech Expediters, Lancasters, Canso amphibians, and de Havilland Otters.

In the past year the Air Transport Command carried a payload of 12,000 tons. It has a tri-weekly transatlantic airlift which carried men and equipment to Canadian bases in Europe, Canadian United Nations truce teams to Indo-China, supplied Canadian and United States jointly operated weather bases on the Canadian Arctic Islands, cooperated

AVRO CF-100

with the Canadian Army on paratroop training, dropped Christmas food supplies to Arctic and isolated defense bases, did a major photographic job in the far north, and flew Canadian cabinet ministers throughout the world including Russia.

Tactical Air Command

The RCAF Tactical Air Command has its headquarters at Edmonton, and its task includes offensive and transport operations and training. Under its control are two auxiliary light bomber squadrons, which would be available for tactical air support of Canadian Army forces.

Tactical Air Command is also responsible for search and rescue operations and various specialized types of training.

During the past year the RCAF added considerably to its fleet of helicopters.

In addition to Sikorsky S-55 and Piasecki H-21A helicopters, the RCAF now has Sikorsky H-34 and Piasecki H-21B helicopters. These were used extensively carrying survey parties, test engineers, supplies, and as a link between radar sites and nearby lakes where fixed-wing aircraft landed supplies for the Mid-Canada radar line.

RCAF Construction

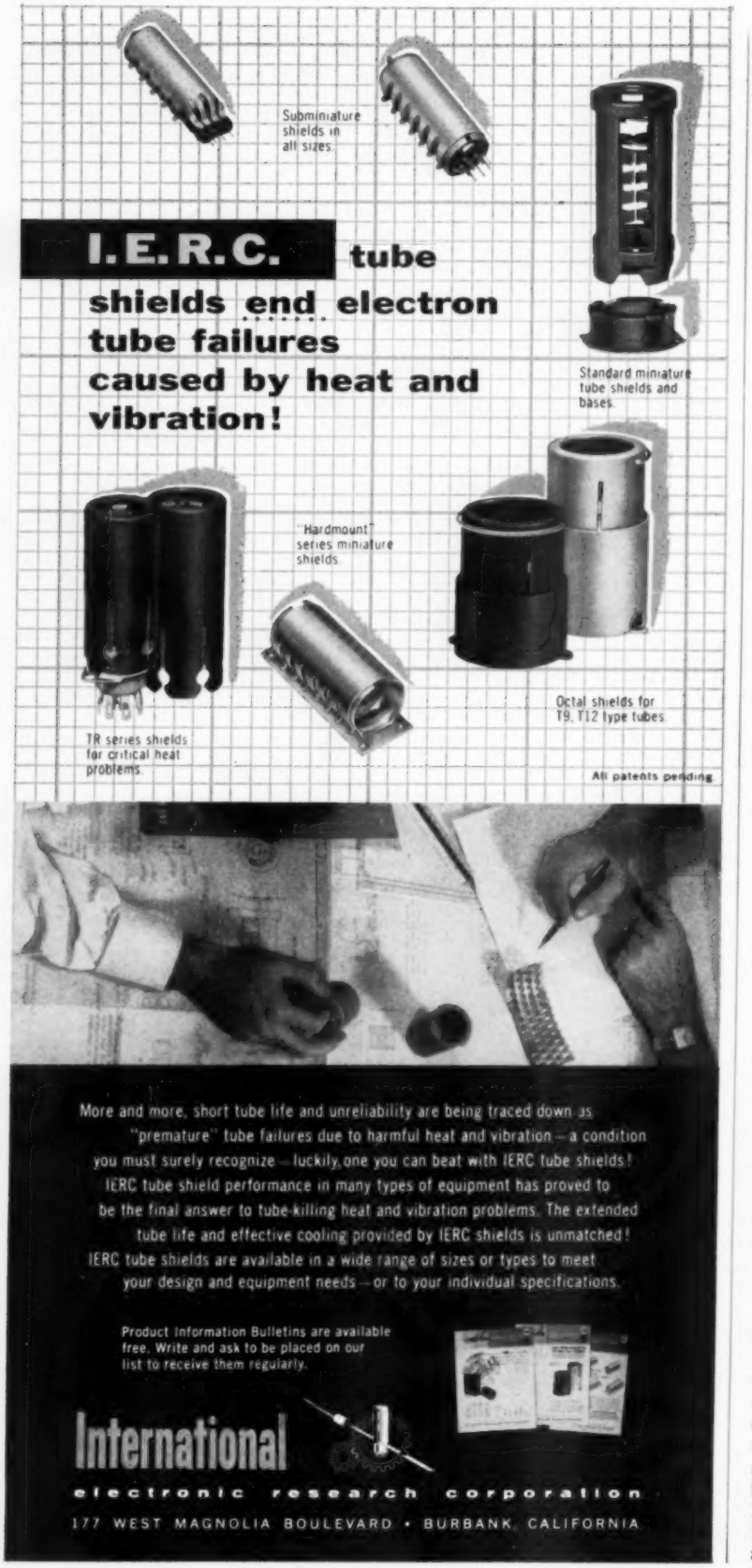
The RCAF's construction program has passed its peak and in the past year concentrated on extension of runways at defense bases to meet the requirements of newer jet fighters.

Major construction job last year and this year is the radar network, the Mid-Canada line which is financed and being built entirely by Canada, and the Distant Early Warning line, being financed by the United States and built in part by Canadian contractors.

The Mid-Canada line, estimated to cost about $170 million, is being built roughly along the 55th parallel of latitude. The DEW line is being built farther north, roughly just above the Arctic Circle. Coordinated with these two radar nets is the southern Pine Tree line, manned in part by Canadian and in part by United States forces, and the planned network along the Atlantic coast and the Alaska system of the United States along the Pacific coast.

Northern Defense

Canada's Defense Minister Ralph Campney recently stated that "northern defense is colossal in scope, difficult of accomplishment, tremendously costly in execution. It bristles with problems and difficulties. It cannot be made perfect; the cost would be insupportable. But we can make our defenses as nearly fool-proof and complete as possible, and we intend to do so. Both Canada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and the United States recognize the urgency of that."

Home-based interceptor squadrons of the RCAF are concentrated mainly in the area across which enemy aircraft from the north would have to fly in order to reach the industrial centers of southeastern Canada and the northeastern United States. Interceptor forces of the USAF are strategically located throughout the United States and near the Canadian border. Cooperation between the RCAF and USAF is close, with the two forces jointly participating in regular air exercises designed to test continental air defenses.

Early warning radar is limited in its ability to detect low-flying aircraft. To remedy this, the RCAF and the Canadian Army have established ground observers among the northern Canadian population. The jointly operated weather stations of Canada and the United States in Canada's Arctic also report on aircraft flying in the far north.

A permanent Canadian Mobile Strike Force has been organized and trained in Arctic warfare in order to repulse any attack by airborne troops on Canada. This force consists of units of the Canadian Army and the RCAF Air Transport Command. United States air and ground forces have also been trained and tested in Canadian Arctic defense exercises in recent years.

Arctic Problems

Research on Arctic defense problems has been carried out by the Canadian Defense Research Board and a joint testing station of the Canadian and United States governments at Churchill, Manitoba.

Among recent developments have been the twilight computer for use in winter months on ice-reconnaissance patrols, and the development of the R-Theta computer for navigational aids without use of radio communication.

The RCAF has also found that the British Rolls-Royce Merlin engine is efficient in Arctic operations, as it is able to start without preheating of any kind, at temperatures as low as 45 degrees below zero. This winter the RCAF has been working at Churchill with a United States-developed low-cost and readily portable ground control approach unit, the Gilfillan Quadradar.

RCAF has also been testing at cold weather stations automatic seat ejection systems for use in T-33 Silver Star jet trainers and Sabre fighters. Automatic ejection seats are in use on the CF-100 all-weather fighter.

There has been some discussion of the Canadian Army starting an aerial wing, in conjunction with paratroop and airborne supply tactics for ground forces. This has not gone beyond the

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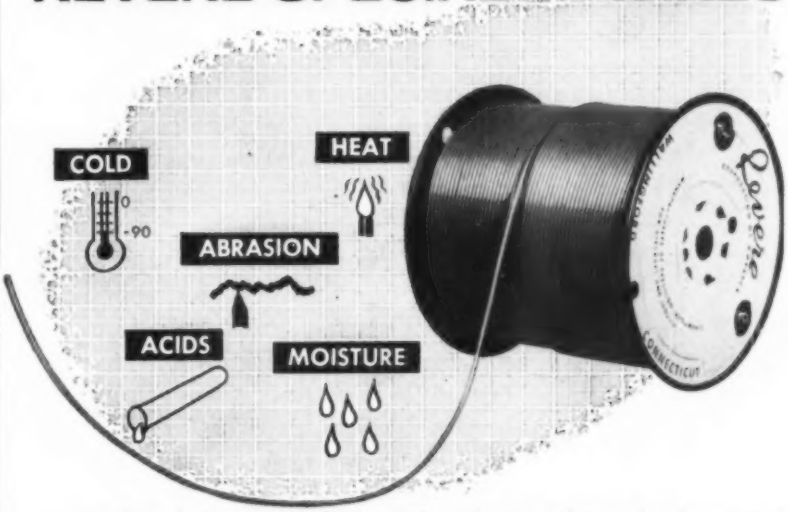

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initial talk stage as yet, as the Canadian government thinking is that the RCAF Air Transport Command fills that role. The Canadian Army has 16 Cessna L-19As for artillery spotting.

But the Royal Canadian Navy has a Fleet Air Arm and aircraft carriers. Early this year the RCN took delivery of its first operational jet aircraft, United States-built McDonnell F2H-3 Banshees. These aircraft replace the British Hawker Sea Fury fighters.

The RCN also has Sikorsky HO4S, Piasecki HUP and Bell HTL-4 helicopters for a variety of uses, including anti-submarine operations.

The Navy also has on order the Grumman CS2F twin-engine aircraft, now being built in Canada.

Canadian aircraft manufacturers expect to have three new military aircraft in the air towards mid-1957, and have at least one new civilian transport in the planning stage. The industry is mainly concentrated in the Toronto and Montreal areas. In the Toronto area, the major activities are:

• **Avro Aircraft Ltd.** is now producing the CF-100 Mark 5 at the rate of 10 a month. This new version of the Canadian-designed all-weather twin-jet interceptor has rocket-firing armament and a service ceiling of 50,000 feet.

Avro Aircraft is now tooling up for production of the CF-105, a supersonic twin-jet delta-wing fighter for the Royal Canadian Air Force. A quantity order, rather than a prototype order, has been given the company. The plane will be powered at first with the Pratt & Whitney J75 turbojet engines with 15,000-lb. thrust, but is designed to take the new Orenda PS13 engine which will not be ready when the first CF-105 aircraft come off the production line. The CF-105 will have a speed of about 1,200 mph. and a range of 1,500 miles. It will be armed with air-to-air missiles.

Avro also has a guided missile section, started in the past year.

• **Orenda Engines Ltd.** is continuing production of the Orenda 14 engine for RCAF's Sabre 6. The plant, which is also tooling up for the PS13 engine, is also exporting its engines in Sabre aircraft to the South African Air Force.

Both Avro Aircraft and Orenda Engines are part of A. V. Roe Canada Ltd., which also owns Canadian Steel Improvements Ltd. at Toronto, and Canadian Car & Foundry Co. Ltd., Montreal and Fort William, Ontario.

• **Canadian Steel Improvements Ltd.** is making titanium alloy gas turbine blades by a secret process and has a trial order from one United States engine manufacturer. The process eliminates most of the machining necessary in other forging processes. The company has added a third forge shop with heavy forging equipment for the manufacture of large forgings in aluminum and titanium.

• **De Havilland Aircraft of Canada Ltd.** has a new factory now producing single-engined Beaver and Otter transports for the RCAF, USAF, U. S. Navy, and other military services.

Biggest undertaking at the plant is tooling up for production of about 100 Grumman CS2F anti-submarine aircraft for the Royal Canadian Navy. This program is now about six months behind schedule, due to a strike of that duration during 1955.

• **Dowty Equipment of Canada Ltd.** is manufacturing some 60 items for the Avro CF-100 fighter. Dowty is doing research for development of hydraulic equipment for operation under conditions much more severe than experienced to date. It will handle some of the equipment for the CF-105.

• **Lucas-Rotax Ltd.** is another subsidiary of a British company located at Toronto for making parts for Avro aircraft and Orenda engines.

• **PSC Applied Research Ltd.,** at Toronto, is one of the Hunting Associates Ltd. group of companies doing

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photographic surveys, aeromagnetic surveys, servicing, selling and renting aircraft of all types. PSC Applied Research is largely an aircraft instrumentation firm, doing work for the RCAF and civilian operators. It is producing the R-Theta navigation computer system developed by the RCAF, as well as a new type of ice detection system and various instruments for airborne radiation detection and photographic and survey work.

The other major center of Canadian aviation is Montreal. Among the firms in this area:

• **Canadair Ltd.**, subsidiary of General Dynamics Corp., is continuing production of Sabre 5 and 6 aircraft for the RCAF, Royal Air Force, South African Air Force, and the Greek and Turkish air forces.

In addition the plant is nearing production stage for a modified version of the Bristol Britannia for the RCAF. Known as the CL-28, this aircraft will be powered by four Wright turbo-compound R3350-30WA engines. The aircraft is to be used for coastal reconnaissance work as a flying platform for submarine detection and attack.

The CL-28 is being considered in another version as a troop transport and for a civilian transport.

Canadair is also producing more T-33 Silver Star jet trainers and has a subcontract for rear fuselages for the Grumman CS2F anti-submarine aircraft being built at de Havilland at Toronto.

• **Canadian Pratt & Whitney Co. Ltd.** is now producing R1340 engines and parts for worldwide sale, and is producing parts for other P&W engines no longer made in the United States, including the R985, R1830 and R2000. The company is producing R1820 engines for the Grumman CS2F, as well as Hamilton Standard propellers and parts for this aircraft. The company also sells and services Sikorsky helicopters.

• **Rolls-Royce of Canada Ltd.** has completed its order for 900 Nene engines for the T-33 Silver Star jet trainers, and is now concentrating on servicing Dart engines for the Viscount turboprop aircraft used by Trans-Canada Air Lines and Capital Airlines.

• **Bristol Aeroplane Co. of Canada Ltd.**, is headquartered at Montreal, where a subsidiary, Bristol Aero Engines Ltd., has an overhaul plant for servicing engines of the RCAF and TCA.

• **Jarry Hydraulics** is engaged in design of nose landing gear for the new Avro CF-105, is making landing gear for the Canadair CL-28 Britannia, nose landing gear for the Canadair Sabre, landing gear for the Canadair T-33 Silver Star, and hydraulic equipment for the de Havilland Beaver and Otter and the Grumman CS2F.

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Spain Looks Abroad For Aircraft Strength

Madrid—Spain's aircraft industry is small and unimposing. It does not pretend to be otherwise, consisting of a number of government-subsidized establishments engaged mainly in experimental work or limited output.

What the country needs for its airlines, it buys abroad. What it needs for its air force, it is getting partly from the United States (F-86s) under the Mutual Defense Assistance Agreement of 1953 and partly from its own plants which turn out propeller-driven Junker 52s, Heinkel 111s and Messerschmitt 109s as needed and in small quantities.

In 1955, Spain built and flew:

• **The Casa-207 Azor** (AW Oct. 17, p. 29), Spain's first tricycle landing gear transport plane. It carries 38 passengers 1,000 miles at a cruising speed of 250 mph. There is only the one prototype, built by Construccion Aeronautica S. A.

• **The HA-200-R1 Saeta** (Dart) jet trainer, a two-seater designed by Willi Messerschmitt for Hispano Aviacion S. A., Sevilla. The plane resembles the American T-28. A second prototype is under construction.

• **The AC-13**, a turbojet helicopter of French design, built under license by Aerotecnica.

• **AVD-12s**, small liaison-type planes (comparable to the American Piper Pacer) constructed by Aeronautica Industrial S. A., which also builds gliders under German license.

The Spanish air force is going through a period of slow reorganization made necessary by the shift from obsolescence to modernity. Most of its 1,200 aircraft are antiquated Junkers, Heinkels and Messerschmitts, but in 1955 Spain received, under the American aid program, its first combat jets: 25 F-86s.

Eventually Spain will have an up-to-date three-wing tactical air force of 230 Sabres, but the build-up is necessarily gradual. Pilots have to be trained and mechanics instructed in maintenance; for this 30 T-33 trainers have been given to Spain.

By late summer, two of the four American bomber bases under construction in Spain will be available for limited operations (Torrejon and Saragossa). Work on the others, and on the fuel pipeline connecting them, has been badly slowed down owing to heavy rains in the fall and winter. It is estimated that by 1958 all four bases will be fully operational, thus bringing the Iberian peninsula within the framework of the Strategic Air Command's worldwide base complex.

Swedish Air Force Plans 25% Increase

Stockholm—After three years of undercutting Royal Swedish Air Force demands for money, the pending 1956-57 national budget provides a $100-million increase in RSAF operating funds. This will make possible a 25% increase in RSAF operational strength during the next two years.

While this does not yet meet the requirements of the 10-year plan put forward in 1954 by Gen. Nils Swedlund, supreme commander of Sweden's armed forces, it is a step in that direction. Swedlund's plan, calling for a 50% increase in the armed forces and a 22% increase in RSAF, is to be hammered into a parliamentary bill.

Included in the new budget are increased funds for development of a pilotless interceptor (resembling the Bomarc missile) and for research personnel in the Air Force Missiles Bureau.

Lansen Replacement

Appropriation of $95 million for procurement of aircraft during the budget year 1956-57 and authorization of orders totaling $128 million mean that the Lansen A-32 attack planes that went into mass production in 1955 will be delivered at "a fairly high rate" over the next two to three years.

First deliveries late this year will replace Vampires and Saab B-18s. Another two wings, armed now with Saab A-29s, will receive Lansens later. Completion of the replacements in the four wings should take place during 1958, and it will include raising the strength of each of the 12 squadrons from 12 to 16 aircraft.

Present backbone of the Swedish Air Force, the Saab-29 Flying Barrel, went out of production in January.

Dragon Fighter

Saab Aircraft Corporation, Sweden's only aircraft producer, has begun tooling at Linköping for production of the new J-35 Dragon, a double-delta jet fighter with a speed of Mach 1.5. Deliveries are expected to start by the turn of 1958-59.

The present one all-weather fighter wing, equipped with Venoms, will eventually be replaced by Lansens and augmented by two more wings. The 10 day fighter wings will be reduced to 8, if General Swedlund's 10-year expansion and modernization plan is approved by Parliament.

The gap between the J-29 and the J-35 will be filled in by Hawker Hunters, first of which arrived in August. Less than one full wing has been delivered, but two wings totaling about 140 Hunters are expected to be in service by the end of 1957.

To further bridge the gap, the new budget provides $3.6 million over the next seven years (about $500,000 a year) for modernization of J-29s by addition of afterburners. This work started at Saab in the latter half of 1955. It is claimed that the afterburner raises the J-29's speed from Mach 0.8 to "about Mach 1."

RSAF Strength

Wing strength of RSAF is a matter of speculation among most foreign observers in Sweden. The size of the Air Force is usually placed at 1,200, which would imply that the force's 50 squadrons are all at full reserve strength of 24 planes each. A recent report set the size of RSAF at 1,500. But the Air Force itself says the total number of planes at "peacetime strength" is 800 to 1,000.

Whatever the size, the Swedes accent modernity and effectiveness. They admit they hold fifth rank in the world only because of the vacuums left by Germany, Italy and France after the war. They indicate that France is probably now on its way to passing them.

Swedish defense aims not to defeat an attacker but to (1) discourage attack by making it appear as costly as

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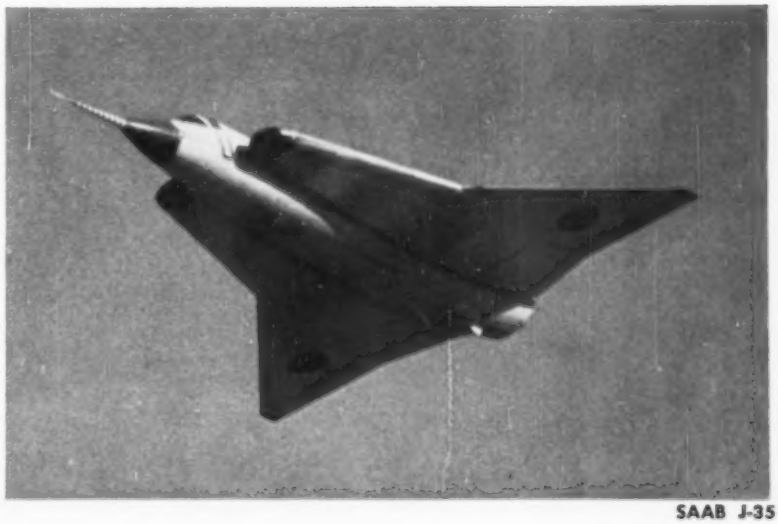

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possible, or (2) enable the nation to withstand attack until help comes. Planners expect help to come very quickly.

Atomic Debate

The drive for effective defense brings the Swedes closer to public acceptance of tactical atomic weapons. A nationwide debate is on in the press, and a showdown in Parliament is expected.

The Social Democratic government's party organ takes the editorial stand that equipping Sweden with atomic weapons would only provoke an enemy (the Socialists never refer to Russia as the enemy) to blast Sweden with atomic bombs. A nationwide opinion poll published in the same paper (Morgon Tidningen) on December 30, 1955, indicates a decline in willingness to fight in face of atomic attack from 83% to 65% in the 21 to 25 year age group, with 76% of the 18 to 20 year olds still willing to fight whether or not an attacker uses atom bombs.

At any rate the Swedish military keeps plugging for acceptance of tactical atomic weapons for artillery and air force. The new Lansen attack plane is designed to carry bombs "of a size corresponding to that of tactical atomic bombs."

Missile Program

Sweden apparently is not wasting time in the field of missiles. After several years of research in this field the Swedish Defense Establishment in 1948 set up a separate organization for guided missiles development known as the "Robot Bureau" of the Air Force Administration.

Exact size of the bureau is not known, but the 1956-57 budget calls for an addition of 59 engineers and technicians. The ten-year plan calls for air defense guided missile units to be included in the air force organization. It earmarks more than $120 million for procurement of "new types of weapons" in the period 1955-65. The bulk of these funds will be spent in the last five years, with the rate running at nearly $50 million a year by 1965. The magnitude of this figure in relation to the nation's resources suggests that "new weapons" may include atomic weapons. But a portion of these funds is definitely reserved for procurement of guided missiles.

Funds for air defense missiles are extra and included in the air force budget. Besides these, procurement plans mention five other types: an Air Force attack missile, an air-to-air missile, two types of missiles for use against naval targets, and one army missile for anti-tank use.

The air force's interceptor missile has been under development since

1954 and will be ready for production in 1959.

Other missiles research is carried on by the Air Force Research Center, which will be expanded by 43 researchers under the new budget. Further missiles research is included under the Defense Establishment's Research Institute.

Navy Missiles

Certain types of missiles are already in mass production. The Swedish Navy set up Coast Artillery test units equipped with guided missiles in 1951 and the use of missiles is now a standard part of training in this branch. Two of Sweden's latest destroyers, the Halland and the Smaland, use guided missiles as the chief weapons. Admiral Erik af Klint, head of the Navy's coastal fleet, said recently that Sweden is well ahead in missiles technique.

The Navy's missile is believed to be a jet-powered development of the German V-1, aimed in the general direction of the target and guided in by an "automatic pilot" target seeker. The automatic pilot is the Saab XA-8, manufactured in the Saab Aircraft Company's equipment plant at Jönköping. Engines for the guided missiles are made by Svensk Flygmotor Aktiebolaget, which stated publicly that they have been doing a good deal of research on ramjets. (Flygmotor makes the Rolls-Royce Avon RA. 7 which powers the new Lansen.)

Counter Measures

While development of guided missiles is being pushed, equal efforts are being made to build up an effective radar network. The head of the Defense Research Institute, Hugo Larsson, recently wrote that radar counter measures should not compete for money with radar aids but that counter radar should compete with other defense measures. Sweden is aiming at counter radar capable of jamming all possible frequencies. Sweden is drawing up an efficient counter radar organization with a unified administration which will prevent technical interference between the three services.

The military research staff is working "intensely" on radar jamming equipment for use against the radar equipment of enemy missiles, aircraft and shore-based enemy radar. Objective is jamming equipment strong enough to be effective across the Baltic where Russia has at least 21 guided-missile launching bases.

How does a nation with such a small market (pop. 7.2 million) and relatively small resources (national income of about $8 billion a year) carry out effective research? In aviation and radar, the answer is that research is

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You hear about new airplanes such as Lockheed's forthcoming propjet Electra airliner, but how often do you hear of the men responsible for them?

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Who are the men solving problems daily to bring all these advancements into actuality?

There's Kelly Johnson, Lockheed chief engineer, of course, the veteran hand with over-all responsibility for the Electra — the man who coordinates the work of the many groups and sections and makes the final decisions.

Immediately below Johnson is N. C. (Carl) Haddon, chief project engineer, and reporting to him is Lon Storey Jr., project engineer on Electra, the man responsible for the propjet liner that will open America's turbine transport age. A Texan, Storey has been with Lockheed 20 years, starting as a design and layout engineer. His experience as project engineer on Lockheed's military turboprop Super Connies assures success for Electra.

Five assistant project engineers report to Storey. They are A. J. (Al) Lechner, 17 years with Lockheed, in charge of structures, wings, fuselage, empennage; R. L. (Dick) Vernon, 16 years with Lockheed, interiors, air conditioning, pressurization, ground handling; R. W. (Reg) Partridge, 15 years with Lockheed, electrical, radio and flight stations; W. R. (Bill) Gordon, 15 years with Lockheed, powerplant, landing gear, hydraulics, fuel system; Howard McGlasson, 16 years with Lockheed, special projects, including customer relations and specification negotiations.

The experience of these men goes back to the original twin-engine Electra and Lockheed's famed Hudson, the XP-38, twin-boom fighter of World War II and the original Constellation.

Assisting them are men of equal experience — group engineers such as H. R. (Harlan) Asquith, hydraulics; R. L. (Russ) Benson, powerplants, and R. W. (Bob) Morris, pressurization, his first such assignment; R. K. (Ralph) Mead, controls and mechanism; A. J. (Ad) Freeman, electrical and radio; Ted Kitchen, equipment; W. E. (Wally) Hobert, flight stations; Jim Power, fuselage; Jim Beach, landing gear; Walt Ayers, wing; D. T. (Dave) Ross, empennage; Frank Bates Jr., weight.

Nor should the engineers in preliminary design be forgotten, although the Electra is now a rushing separate project under Storey.

This section, which accomplished the initial work on the Electra, is headed by P. A. (Phil) Colman, chief preliminary design engineer. Reporting to him are J. (Jimmy) Hong, chief aerodynamicist, and E. C. (Gene) Frost, preliminary design division engineer. R. R. (Dick) Heppe heads up aerodynamics under Hong, who also supervises thermodynamics, flight dynamics and wind tunnel testing, while W. H. (Bill) Statler is the expert on preliminary transport design reporting to Frost.

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mobilized on a nationwide basis. Instead of competing with each other, the firms and government organizations in this business work hand in hand.

The Saab Aircraft Company does not compete for wind tunnel time, for instance. Altogether, there are 15 wind tunnels in the country, and Saab has the biggest transonic and supersonic tunnel, which permits research at speeds up to Mach 1.6. The country's biggest tunnel is an intermittent type owned by the government.

The government set up its Board of Mathematical Machines in 1948 to design and build an electronic "brain." Its binary-electronic sequence calculator has been at the service of Swedish industry now for three years. When Saab found it was delayed, competing for time at the Board (which operates the machine on a commercial basis), the firm built its own in Linköping.

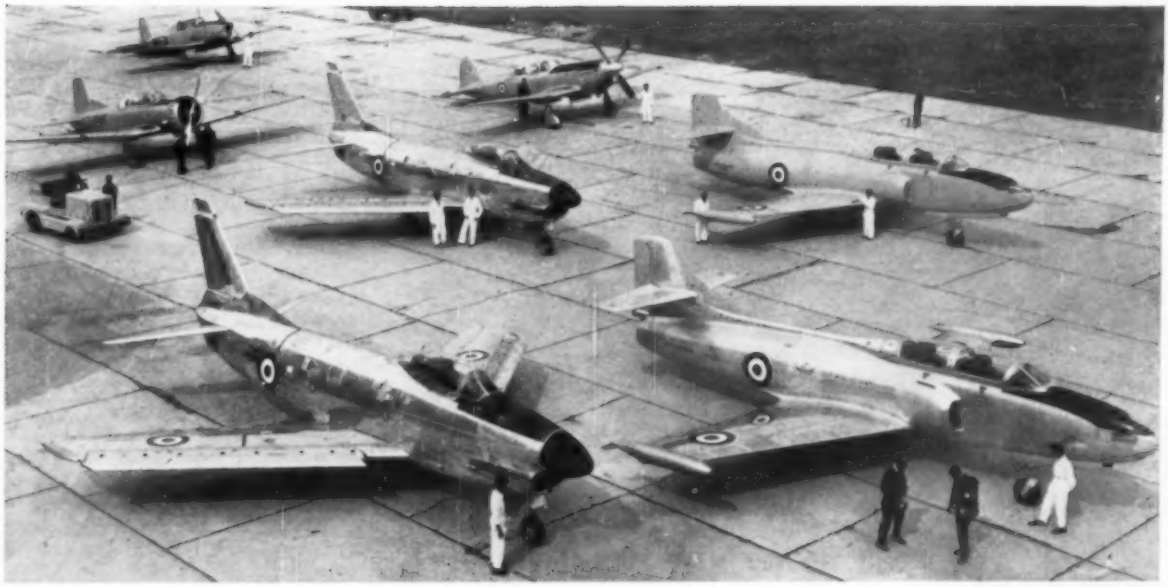
Personnel Shortage

One area where Swedish research is highly competitive is in personnel. There is an acute shortage of high-level engineers, and private industry's ability to overbid the government makes it extremely difficult for the government to meet the rather broad personnel requirements for its research activities. In 1955 private industry itself–Saab in particular–suffered the jolt of having a number of senior engineers whisked away by Lockheed.

To ease the shortage Saab started its own university-level engineering course four years ago. This night school is run at Saab for its engineers who have a degree which would rank about as a vocational school certificate in the U. S. When engineers finish the course, they receive a university degree. Saab engineers teach aeronautics at the Royal Institute of Technology.

Sales figures at Saab are top secret. However the firm's year-end report (June 30, 1955) says that invoicing during the fiscal year was nearly as high as in the previous year but that gross profit was down due to the high costs of phasing out the 29 and phasing in the Lansen. Gross profit was a little over $4 million, against just under $5 million the previous year, and net profit was $1.3 million against $1.6 million.

During the last five years, a January 1 report said, Saab has invested more than $12 million in new plant and equipment. During the same period employment has increased about 50% to over 6,000. This includes a major expansion of the aircraft assembly plant at Linköping, a design and calculations office building, a large production flight test hangar, the new wind tunnel, an assembly building for sub-assemblies (wings) at Trollhättan and aircraft equipment factory at Jönköping.



FIAT'S CONTRIBUTION

NATO Orders Back Up Italian Aviation

ROME—The Italian aircraft industry definitely took its place in the aeronautics plans of the NATO countries in 1955. This is the result of the defense engagements undertaken by the Italian government and the off-shore orders received in ever larger number.

Italian manufacturers now are convinced that efforts should not be devoted to new initiatives of doubtful issue, but that all productive activities should be devoted to specialized fields related to the needs and possibilities offered by NATO's plans for airpower. This has meant active revival and expansion of some factories. On the other hand there was a halt in the work devoted to planning types of Italian airplanes and fewer orders from the Italian government, leading to depression among those companies without off-shore orders.

Activity in off-shore orders may be summed up as follows:

• **Fiat is assembling** some 300 F-86K fighters for which it has a license from North American Aviation. Fifty are assigned to the Italian air force, 76 to the Netherlands, 80 to Belgium, 120 to France. Some 50 were assembled in 1955 in Fiat's new works.

This first series has been made with imported parts, but Fiat in collaboration with Macchi of Varese, has started making an ever larger number of the parts of this plane which are assembled in place of the original American parts.

• **Fiat also overhauls** F-86Ds used by the USAF.

• **Fiat has an order** to make parts needed for ordinary upkeep of the Allison J35, General Electric J47, and Curtiss-Wright J65 engines.

• **Aerfer** of Naples, under a collaboration arrangement with Republic Aviation Corp. makes spare parts for the F-84G. Part of these orders are for parts of the landing-gear.

• **Contraves** of Rome is making an Oerlikon ground-to-air missile.

Since last year the U.S. has introduced a new form of aid to the aircraft industries of the allied countries, financing projects for new weapons. Italy has received two important orders: one for three prototypes and 27 preseries models of Fiat's G.91 tactical light fighter, and one for the Ariete, a light interceptor fighter, built by Aerfer.

The G.91 is fitted with the Bristol Orpheus engine. The Ariete prototype will be a derivation of the Saggitario II, but with an auxiliary jet engine, the Rolls-Royce Soar, added for use when taking-off, climbing and in battle. The Saggitario has a Rolls-Royce Derwent 9 engine.

The Ariete will start flying in 1956 and its performances may mark an important turning point in the construction of low-cost, supersonic planes.

Another prototype is being built in the Agusta works at Cascina Costa without American aid. It is a twin turbojet plane, the AZ8L, for use as a transport plane on inland and inter-European lines.

The operating Italian air forces are now all organized in the new 15th Tactical Air Force. All the Italian air brigades of fighters at the disposal of the NATO are equipped with F-84s. New brigades that are being formed will have the F-86K. The tactical reconnaissance groups are equipped with RF-84s. A brigade of Fairchild C-119 transport planes has also been made available.

During 1956 these Italian units will be strengthened by one or two air brigades while those already formed will be completed.

When this program is carried out Italy will be able to place some 950 planes at the service of NATO.

In addition to these forces, Italy has a certain number of air brigades and wings for the defense of her territory and for training. These consist of some 500 planes, mostly old fighters fitted with piston engines and some Fiat Vampires.

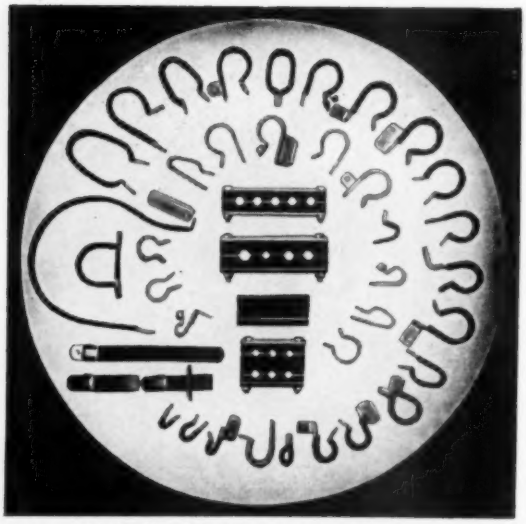
Italian experts judge that the chief progress made by Italian aviation in 1955 took place in the training of the pilots.

The larger budget appropriations and the exemption made in favor of the air forces of 90% of the very heavy duties levied on fuels used by jet planes, has made it possible to increase the hours of flight of the staff by an estimated 100 to 200%.

The hopes of the Italian aircraft industry are based above all on the expansion of its activities for the air forces of the NATO. Thus, Fiat counts on large orders for its new G.91.

Fiat also counts heavily on being given the work of overhauling all F-86Ds

Cost Saving Ideas...



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of the USAF in Europe (some 500 as against the 50 entrusted to it in 1955).

It is hoped that the work of making the spare parts for the several American jet engines may be assigned to Italy. This is also hoped for with respect to supplies required by the allied countries in the Mediterranean area.

In the case of missiles, it is expected that the mass production of the new special electronic percussion Bofors rocket will be started. General Electric has taken the license for its production, and in turn has granted it to Fiat.

Fiat is prepared to organize the production of similar rockets through the several concerns belonging to its group, such as RIV and Microtecnica.

Macchi reached agreement with Lockheed in January, under which it is recognized as the only European factory authorized to work on the T-33.

Piaggio, which has had only off-shore orders for the upkeep and overhaul of Continental engines for the liaison planes, looks forward to building the P-149 primary training plane, of which Germany has purchased 30 and will build another 270 under license.

Finnish Production Below Pre-War Level

Helsinki—Finland's aircraft industry is negligible. Her military air establishment is relatively weaker than that of the British on Crete during World War II.

One factory producing aircraft is the Valmet (State Metal Works) aircraft establishment in Tampere. Its present production is 10% of pre-war. Since 1945, it has turned out and delivered to the Finnish air force 30 Wihuri trainer planes (piston engined, mounting a machine gun). It has contracted to deliver 20 more by July.

Strength of the Finnish air force is limited by the Paris Peace Treaty of 1947 to 60 first-line aircraft and a personnel strength of about 3,000.

The most modern plane is the British Vampire jet trainer. Ten of 15 ordered have been delivered. One has been totally destroyed, another almost written off—in crashes. So the total flying strength of Vampires will be 13. There are two Blenheim bombers, used last summer on maneuvers for artillery spotting. Numerous trainers and obsolete wartime aircraft bring the plane strength up to the full 60.

The Finnish air force personnel strength now stands at about 1,550 in all ranks.

The Karhumäki Airlines, which now concentrate on scheduled services, have designed a 4-seater with a Lycoming 190 hp. engine, for use with wheels, floats or skis. The prototype is ready, but production plans have been halted.

German Industry Awaits Orders

By Gerald Schroder

BONN—West Germany's aviation industry is on the threshold of resuming operations. The Defense Ministry probably will place initial orders sometime this spring.

These orders will be modest and will not include tactical aircraft as yet. Bonn planners believe the industry will not be capable of producing tactical planes for another four years at least.

The industry has, in the meantime, organized itself into so-called "working committees." Each consists of several producers who, in turn, have agreed to cooperate on certain projects.

The "working committees" are:

• **Flugzeugbau Nord GmbH.**, consisting of Franz- und Verwaltungsgesellschaft Weser GmbH., Siebel ATG, Hamburger Flugzeugbau GmbH. (Blohm & Voss), and Henschel & Sohn, Kassel. This group will probably build the French Noratlas.

• **The second group** consists of Focke-Wulf Flugzeugbau GmbH. and the engineering bureau of Prof. Blume, Duisburg. This group will handle construction of the Piaggio P-149.

• **Ernst Heinkel A. G.** and Messerschmitt A. G. form the third group, which is planning to produce the Fouga Magister.

• **The fourth group** is headed by Dornier-Werke GmbH., with other firms to join later. This group will concentrate on building the DO 27.

No Orders

At this point, no firm orders have been placed with any of these groups. Financing remains one of the most sticky problems to be solved before production can start. Industry officials estimate that between 40 and 50 million deutschemark will have to be "found."

While these groups concentrate on non-tactical aircraft, all other material will come from U. S., British and French supplies, under NATO arrangements. Although plans are flexible, no basic changes have been announced at this date in the basic makeup of the budding German Luftwaffe.

Twenty wings will be established, composed of:

• **Eight fighter wings** of 75 planes each;
• **Two all-weather fighter wings** of 36 planes each;
• **Two reconnaissance wings** of 54 planes each; RF-84Fs are being considered;
• **Two transport wings** of 48 planes each;
• **Six fighter-bomber wings** of 75 planes each; probably F-84Fs.

Although German air force planning is tied completely into NATO strategic and tactical thinking, it is obvious that the Germans see their new airpower primarily as a shield to protect Germany from any attack from the East.

The Germans will not fly heavy bombers. They will concentrate on extremely light, fast fighters which can rise to meet the enemy in the least possible time. The Germans reportedly are dissatisfied with all models that might be offered them by NATO. They express admiration for the "over F-100" series now being developed in the U. S.

German planners are still hopeful that someone will come along with a very fast, light plane that can be produced easily and relatively inexpensively in existing German facilities.

The Germans still retain, or have rebuilt, many important construction facilities.

Here, for the first time, is a complete run-down of German production facilities:

• **Focke-Wulf, Bremen:** This firm owns five hangars, in poor shape, adjacent

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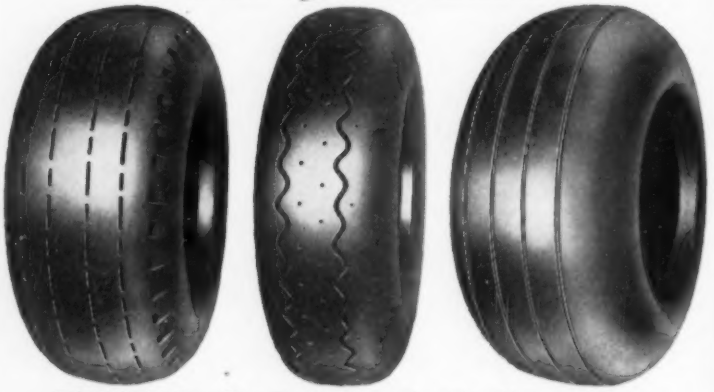

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to Bremen airport. There is a total of 500,000 sq. ft. in floor space; the firm employs about 250 workers and 50 white collar workers. There are 150 aluminum working machines on the premises. There is a runway of some 6,000 feet. The firm may not be in very good financial condition. In 1944, the Bremen plant (one of seven wartime Focke-Wulf plants) produced 250 FW 190s monthly. Now the plant only produces gliders (against firm orders) and light metal parts for ships.

With the construction office of Prof. Blume, this firm will probably swing into production with orders for the Piaggio P-149. While facilities are meager, Focke-Wulf reputation is high.

• **Weser A. G., Bremen:** Friedrich Krupp, Essen, reportedly owns 80 percent of this firm, now capitalized at the nominal sum of DM 4 million. The firm owns the "Motorenwerke Varel" plant, which has 181,000 sq. ft. and is in excellent physical shape. Weser A. G. could easily utilize existing machines and machine tools from the Weser shipyards, owned by the same Essen firm. It is probable that the main part of the fuselage and the final assembly work of the Noratlas will be done in this plant.

Weser A. G. also owns a plant at Lemwerder, with 387,360 sq. ft. of usable floor space.

• **Blohm & Voss, Hamburg:** The plant here has a floor area of 600,000 sq. ft.; all buildings are in excellent shape; there are 240 machine tools on the premises. There is an airfield adjacent, limited to less than 8,000 feet. The firm is in excellent financial condition. When final orders come through, this plant will join in building the Noratlas. This plant is considered the best equipped for plane production in the Federal Republic.

• **Henschel, Kassel:** This firm, with extensive holdings in the Kassel area, is capitalized at DM 45 million and has an annual turnover of DM 180 million. Three aeronautical designers are now reportedly on the staff. Henschel now makes locomotives, trucks and buses. It has the sales rights in Germany for Sikorski helicopters.

• **Daimler-Benz, Stuttgart:** Well-known for its cars and trucks, Daimler is in excellent financial shape. Production facilities are such that it is the logical producer of jet engines in Germany. The firm has indicated strong interest in obtaining license rights from abroad.

• **Ernst Heinkel A. G., Stuttgart:** It employs 30 aeronautical engineers, headed by Siegfried Guenther. Heinkel produces motor-scooters and bikes. The firm has adequate machine tools along general-purpose lines. Heinkel also owns a plant in Speyer, now occupied by the French forces. If this plant

is returned, and the German government builds an airstrip there, Heinkel would like to resume production in the Speyer set-up. Heinkel now employs 1,250 workers and has an annual turnover of DM 35 to 40 million. Heinkel will help in making the Fouga Magister.

• **Dornier, Munich:** The Oberpfaffenhofen plant has four hangars and 420,000 sq. ft. of floor space. During the Berlin airlift, the USAF overhauled DC-3s there. The Dornier plant at Neuaubring will produce the DO 27. The Oberpfaffenhofen plant has the only good private airstrip in West Germany, a concrete strip of 7,500 ft.

• **Bayerische Motorenwerke (BMW), Allach:** The plant was used until June 1955 as an overhaul base for U. S. Army vehicles. Some 7,000 workers were employed in this plant. A part of the plant has now been sold to MAN; the remainder is in good condition, and suited to the production of aircraft engines.

There are 52 test stands capable of testing jet engines. There are also 14 test bays where rockets were tested during World War II. BMW employs 6,000 persons in Munich, none at Allach at the present time.

BMW's research department is headed by Dr. Helmut Sachse, an aircraft engine specialist. There is a nucleus of 12 aircraft engine specialists.

Peak production at Allach during World War II was 2,000 nine- to 14-cylinder motors monthly for the FW 190 and the Dornier 217. In 1944, the firm produced jet engines on an assembly line basis in conjunction with Junkers. Rocket development was in a highly advanced stage with 40 rocket specialists on the staff during the war.

BMW faces certain difficulties since the plant is owned by a large number of small stockholders. Most of these shares, as is the German custom, are voted by a bank; in this case, the Sueddeutsche Bank. The bank is pressing the firm to sell the Allach plant.

• **Messerschmitt, Augsburg:** Messerschmitt facilities at Angsburg and Regensburg were up to 70 percent destroyed during World War II. Production facilities now center in Augsburg where Messerschmitt makes sewing machines, motor-scooters and wood cabinets for radios. The firm owns some fairly heavy presses and a good stock of small, general-purpose machine tools. Capital is rated at DM 5.6 million and annual turnover at DM 30 million. There is a 4,000 ft. runway next to the plant. Messerschmitt will be prime contractor for the Fouga Magister. Messerschmitt employs some 2,000 workers; a good ten percent of these have aircraft production experience as designers, engineers or skilled workers.

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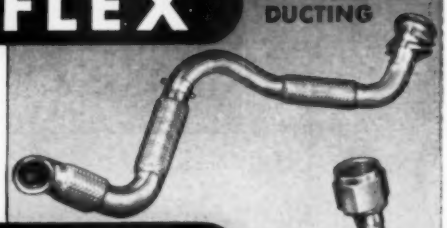

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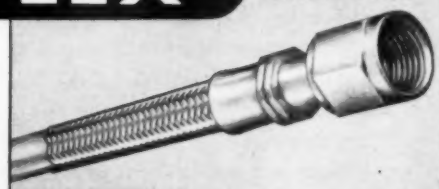

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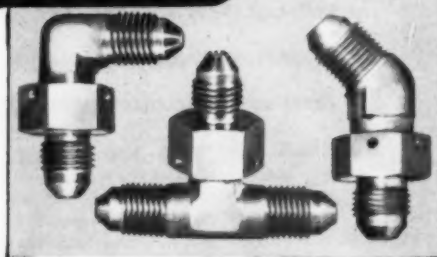

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India Expands Airline, Production Potential

New Delhi—India's expanding air picture—both civil and military—was highlighted last year by international developments:

• **India terminated** the Indo-U.S. Air Agreement of 1946 because of differences of opinion on 'Fifth Freedom' traffic.

• **Representatives of India and Japan** initialed the long-awaited bilateral air transport agreement.

• **New Delhi and Peking** agreed, in principle, to extend the Air India International Calcutta-Hong Kong run to Shanghai and Peking.

• **Chief of Air Staff,** Air Marshal Sobrito Mookerjee visited Moscow and spent three weeks inspecting Russian factories and air installations. Out of this visit was born the idea of presenting Mr. Nehru with an Ilyushin-14 as a possible forerunner of other Ilyushins with higher digit numbers for the Indian Air Transport Command. The Ilyushin-14, designated a VIP aircraft, has been handed over to the Indian Air Force. Together with a specially-built Viscount for the President of India, the IAF is now trying out these aircraft to decide which would be more suitable for its Air Transport Command.

The Russian plane is now being flown and evaluated by air force pilots, after the entire manual of instruction was translated from Russian into English and Hindi.

• **Government-owned** Hindustan Aircraft Ltd. (HAL) announced it was near agreement with Folland for the manufacture of the Gnat lightweight fighter. This agreement is to be ratified early in 1956.

HAL also has been showing the Indian-built HT-2 trainer to several Southeast Asian capitals and now reports orders from Colombo, Rangoon and Bangkok.

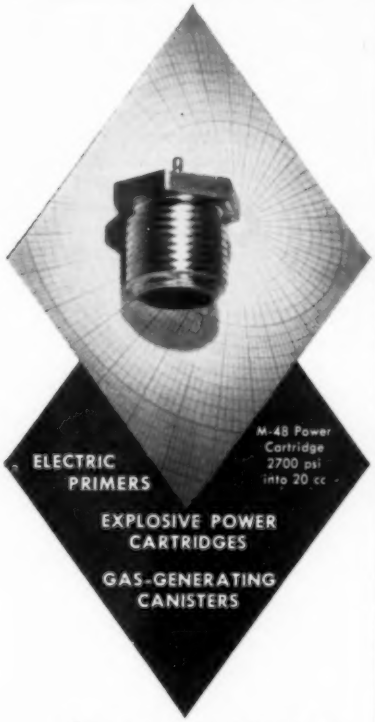
The Indian Air Force started 1955 with 100 jet fighters and its first Indian air marshal.

It spent the first six months of the year deciding whether it wanted more French planes (among the jets are two squadrons of Ouragans) or could arrange for the manufacture of light fighters in this country.

Pakistan's growing air strength, however, is being closely watched, and the Indian Defense Ministry is reported to be budgeting for an increase in fighter-power over the next three years.

This is having considerable overall effect on the air force's pilot-training programs. Many Indian pilots are now going straight from the Defense Academy to Britain and France for their operational training.

SQUIB SPECIALISTS



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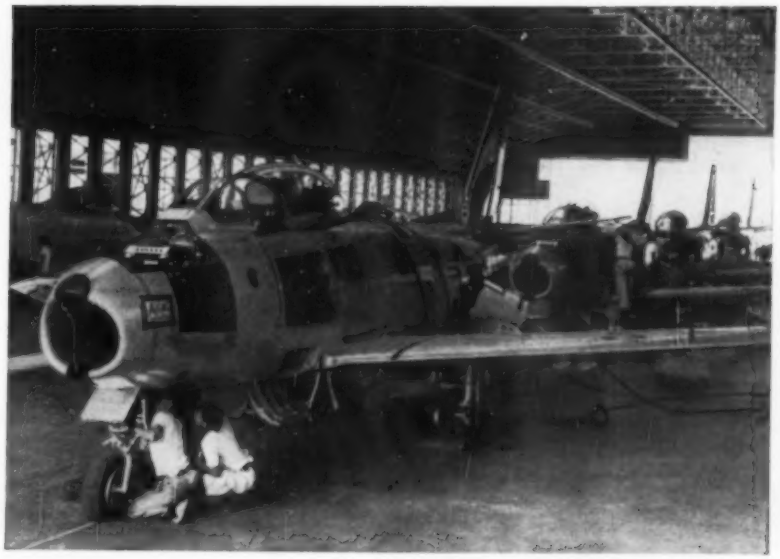


MITSUBISHI OVERHAULS USAF F-86

Japan Makes Its Jet-Age Bow, Lays Foundation for New Air Arm

By Dan Kurzman

Tokyo—The Japan Air Defense Force, activated in July 1954, is still in a preparatory, non-operational stage of development. But the foundation for a strong air arm was largely laid in 1955. This includes plans for domestic assembly and manufacture of F-86 Sabrejets and T-33 jet trainers. The initial T-33 was completed in December and flown in January.

U. S. Air Force units now in Japan may start withdrawing by 1960, but American military officials are not optimistic that JADF will meet the necessary time-table. They think the native air force buildup made so far, is too slow. Only $32.8 million, 13.6% of a total defense budget of $240 million, has been devoted to the air force in fiscal 1955-56.

This percentage is expected to increase gradually to about one-third of defense costs in 1961. Many Americans feel that the air force should take a more important role than this. Japan, an island nation not easily accessible to enemy ground troops, must depend to a large degree on control of the air to stop aggression.

Japan's neutralist-tinged public appears to be even more opposed to development of a strong air force than of a large ground force. Plagued with memories of Hiroshima, many Japanese fear that a buildup of airpower will invite new nuclear destruction. Unless this attitude changes, withdrawal of American air units from Japan may be considerably delayed.

Even so, Japanese airpower is not by any means at a standstill. In December 1954, it had only 25 T-34s. One year later its inventory listed 324 planes, including six F-86Fs, 68 T-33s, 95 T-34s, 130 T-6s, and 25 C-46s.

By December 1956, JADF inventory is expected to comprise 514 planes: 100 F-86Fs, 100 T-33s, 127 T-34s, 155 T-6s, 28 C-46s, and four helicopters. At the end of 1957, an air force of 779 planes is called for: 250 F-86Fs, 25 F-86Ds, 180 T-33s, 127 T-34s, 155 T-6s, 32 C-46s, and 10 helicopters.

Personnel will increase from 9,000 in 1955 to 16,000 in 1956 and 23,000 in 1957. The pilot roster will lengthen from 230 to 560 this year and 980 next year.

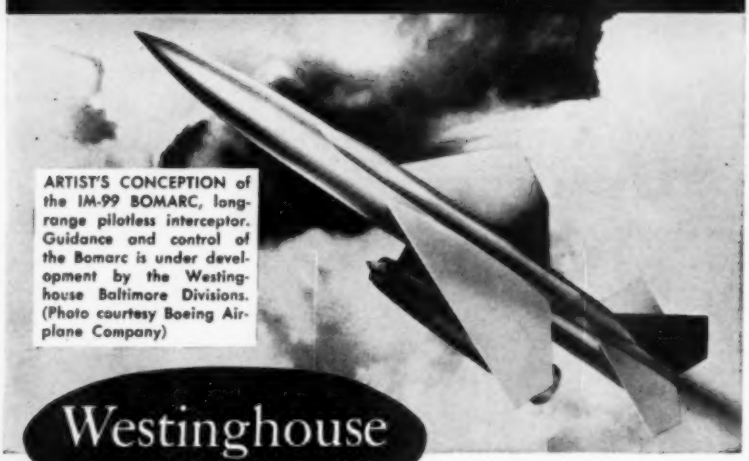
JADF also is acquiring more air fields. USAF recently turned over Matsushima Air Field for T-6 flight training. JADF also started sharing USAF training facilities at the Tsuiki and Miho air fields last year.

Sabre Base

The Japanese in 1954 took over Hamamatsu Air Field, a war-damaged base, which they have completely rebuilt. Work has started on extending the runway from 4,000 to 7,000 feet to permit use of the F-86.

Fifty Sabrejets from the U. S. will be stationed here for training purposes beginning in June or July. Meanwhile F-86 operations have begun at

electronics engineers:



ARTIST'S CONCEPTION of the IM-99 BOMARC, long-range pilotless interceptor. Guidance and control of the Bomarc is under development by the Westinghouse Baltimore Divisions. (Photo courtesy Boeing Airplane Company)

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Tsuiki in southern Japan. JADF's first radar equipment—Japanese made—will be installed in the summer.

JADF hopes to start tactical F-86 operations in October at either Niigata or Komatsu. But it may be delayed until early 1957. Negotiations are underway for the joint use or full control of these two fields, as well as of Chitose and Misawa air bases.

Most JADF planes and supplementary items—only the T-34s and some machinery and communications equipment are produced domestically—have so far been acquired under America's Mutual Defense Assistance Program.

The native aircraft industry, including three major and six minor companies, registered a gross business exceeding $8,000,000 in 1955. The figure is expected to jump to more than $14,000,000 in 1956.

Profits Dubious

Profits will be moderate or nonexistent because of the large capital expenditures needed to lay the foundation for this new post-war industry. In 1955, the industry spent about $6 million on new and improved facilities and equipment, approximately $500,000 more than in 1954. Outlays for this year will exceed $15 million.

Kawasaki Aircraft Co. completed assembly in December of its first T-33 jet trainer, of which 100 will be turned out by June 1957 with technical aid and parts from Lockheed Aircraft Co. (AW Feb. 20, p. 57). Another 80 planes will probably be produced from July 1957 to April 1958. The U. S. is spending $11 million (parts, technical aid, etc.) and the Japanese government $7 million (transport, labor, etc.) for the first 100 planes. Kawasaki will have spent $4 million for new production facilities and $2.8 million for repairs.

Kawasaki and Lockheed are already considering producing the F-104.

Except for the one T-33, Kawasaki confined its production last year to one KAT-1 liaison plane, which it started manufacturing in 1953, and 14 Bell helicopters—an increase of eight over 1954—under a technical accord with the Bell Aircraft Corp. Helicopter output will jump to 24 in 1956.

Kawasaki also overhauled 453 engines and 167 airframes for USAF and JADF.

Sabre Production

Mitsubishi Heavy Industries, Ltd., will start assembling F-86 Sabrejets this spring with parts and technical aid from North American Aviation. The first will be completed by October. The firm will assemble 70 planes by June 1957, and probably 110 more by June 1958. For the first 70, the U. S. will provide about $18 million (parts, technical aid, etc.), and the Japanese

government $7 million (transport, labor, etc.). Mitsubishi will spend $11,000,000 for new production facilities.

Mitsubishi spent about $1 million in 1955 repairing its existing facilities. It overhauled about 150 F-86 airframes for USAF in 1955.

Japanese Engines

The T-33 and F-86 airframes to be assembled and manufactured in Japan may be fitted out soon with domestically-made jet engines as well, under a $50,000,000 program recently submitted to Washington. Kawasaki would produce 350 J33 engines over a five-year period starting next September; Ishikawajima Heavy Industries, 850 J47 engines over the same period beginning in April 1958.

The Kawasaki project calls for technical aid and the purchase of equipment from the Allison Division of General Motors through Lockheed. Ishikawajima would receive similar help from the General Electric Co. The J33 venture would cost about $20,000,000, and the J47 program about $30,000,000, 70% of each bill to be paid by the U. S., 30% by Japan. The U. S. share, however, would gradually decrease, amounting to only 15 or 20% by the end of each five year project.

Fuji Heavy Industries, Ltd., under a contract with the Beech Aircraft Co., assembled 34 and manufactured 27 T-34s in 1955. Fifteen T-34s were assembled the year before. In 1956, it will manufacture 36 in all, and will no longer require knockdown aircraft and technical aid from Beech.

Fuji also produced a T-34-type LM liaison plane in 1955 on an experimental basis and is now negotiating with the U. S. Air Materiel Command for the sale of 24 this year.

The company spent about $2,000,000 for new equipment and facilities in 1954 and 1955.

Neptune Plans

The U. S. and Japan are now negotiating for Japanese assembly, and eventual manufacture, of the Navy's Lockheed P2V-7 Neptune. Work may start by June, although production probably wouldn't get underway for another year. Under this program, $100 million would be spent over five years for the assembly of 75 planes. Shin Nippon would assemble the wings and tail surfaces, Shin Meiwa the balance of the airframes. Both are now overhauling planes for the U. S. Navy.

Shin Meiwa plans to spend $3,300,000 and Shin Nippon $4,278,000 on expansion and rehabilitation of their plants if the program goes through.

The first post-war Japanese-designed plane, an intermediate jet trainer lighter than the T-33, may come off the production line by summer, 1957. JADF

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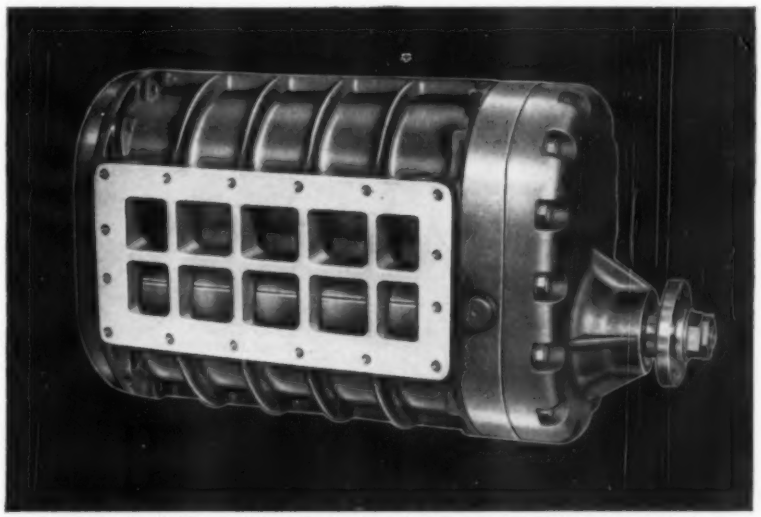

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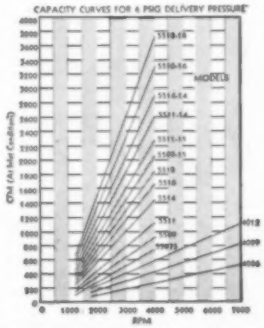

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has requested Fuji, Kawasaki, Mitsubishi and Shin Meiwa to draw up designs.

Guided missile research is also underway. About $27,800 has been spent since April 1954 on gathering data and preliminary experimentation with powder rocket propellants. Another $16,700,000–$1,500,000 in the first year–will be spent on a five-year program starting in April, when the experimental manufacture of a small surface-to-air missile will begin.

Firing tests will probably be held by October 1957. Actual production of short-range (30 km.) missiles may start in 1959, of medium-range (50-60 km.) missiles in 1961, and of "long-range" (100-150 km.) missiles in 1963. Japan will start negotiating soon with Oerlikon of Switzerland for the purchase this year of ten Model 55 guided missiles and supplementary equipment for test purposes. These items will probably cost about $1,000,000.

New Argentine Junta Revamps Air Policy

Buenos Aires—The revolution of last year, which ousted Dictator Juan Perón and his regime, is changing Argentina's aeronautical policy.

The Argentine air force's latest inventory includes: 20 Avro Lincoln bombers, 150 IA Calquin light bombers, 80 Gloster Meteor interceptors, 200 Percival Prentice trainers, 30 Beech AT-11s, 30 Fiat G-55 trainers, 25 Douglas DC-3s and C-47s, 30 Bristol 170s, 50 de Havilland Doves, 8 Douglas DC-4s and 30 Vickers Vikings.

The ministers believe this inventory is obsolete and in great need of a thorough overhauling.

They also recognize that the state-owned airplane industry of Cordoba province, Industrias Aeronáuticas del Estado (IAME), has not reached the stage where it can deliver the types of planes required for modern airpower. The country does not possess the necessary materials and expert know-how and, even if did, the state no longer can bear the financial drain for continued support of such an industry.

Important decision by the Ministry of Aeronautics is a project for the state's gradual withdrawal from direct participation in the aircraft industry. Commodore Julio César Krause, Minister of Aeronautics, said: "State intervention in IAME will be decentralized in a three-year plan to deliver it to private industry, with which a greater vitality of its activities will be assured." Private aviation circles, conscious of Argentina's nationalism, think it will take longer than that to loosen the government's 29-year grip on IAME.

Overhaul of any major portion of Ar-

gentina's air force requirements through importation is postponed by the lack of foreign exchange. Other than for urgent transport and industrial machinery, there is no indication that air force needs are covered in the $1 billion foreign loans prescribed for emergency use in Raul Prebisch's economic recovery report, and which Argentina seeks in the U. S. and Europe.

Aviation Problems

Other factors which bear on Argentine airpower:

• **Will Argentina lean** heavily towards the United States for its future needs of aircraft materiel and know-how? Air men stress that what is needed most is close coordination with USAF. The first step will be the invitation for a USAF mission to train pilots and offer advanced air defense instruction. The last USAF mission left in 1951.

• **Until decisions can be made** on IAME's ultimate destination, plant facilities are to turn out aircraft in types and quantities economically feasible to produce in the country. Much of the plant's future production will meet the hard-pressed civilian requirements.

• **To satisfy** some of the more immediate needs, IAME will produce 100 IA 35s, a multi-purpose, all-metal two engine aircraft. It is built entirely locally and can be used for bomber training, advanced training, exploration and reconnaissance, transport of passengers and cargo, and ambulance service.

• **The Central Bank has decided** to allow importation of all types of aircraft and parts at the official rate of 18 pesos to the dollar, instead of the free rate, now over double that value.

• **Importation of small airplanes** is anxiously awaited by some 5,000 civilian pilots, licensed over the past five years, many of them ready buyers. Last year alone, 1,007 young pilots passed training courses in more than 100 clubs.

Research Interrupted

The interruption of last year's research and development program coincided with the expiration of employment agreements which IAME had with its last group of foreign engineers and designers, mostly former Luftwaffe advisors. Among those affected by the contract expirations are: Kurt Tank, Hans Rudel, Eric Lollmann, Ernest Probst, Gerhard Starke, Rudolf Schoffel, Hans Gottschalk and Gotthold Mathias.

Some of the projects that these men abandoned were: Pulqui III, a night-fighter version of the Pulqui II (AW May 16, p. 45); the Pulqui IV, a supersonic fighter developed from the IA37 delta scale-model that was flown in glide tests during the latter part of 1955; and a four-jet transport plane. Progress on this last project was held up last April by shortage of both materials and funds.

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● AUSTRALIA

RAAF Has Lean Year in Aircraft

Melbourne—Political, economic and manpower problems have combined to check the ambitious plans for expansion of the Royal Australian Air Force. Some progress has been made in re-equipment with more modern aircraft.

RAAF personnel is in the vicinity of 15,000, and enrollments are unlikely to make up for the losses.

No new types of aircraft were introduced in 1955. The long-postponed introduction of Avon-Sabre into squadron service is now scheduled for this month. First unit to get Sabres will be No. 3 squadron of the 78th Fighter Wing at Williamstown, New South Wales, and scheduled for duty in Malaya.

Lincoln bombers have been completely replaced by locally-built Canberras in two squadrons of the 92nd Bomber Wing. Third squadron is in Singapore and will be withdrawn in 1956 for re-equipment with Canberras.

Fighter orders can hardly be postponed indefinitely. But the decision is not easy. RAAF is short of funds. One school argues that Australia should rely on her Allies (read: U. S. A.) for free supplies of aircraft. Then there is the British pressure for British orders.

Despite some outstanding failures, the Australian aircraft industry will probably be given the job of locally producing a plane from a U. S. airframe and a British engine. A leading candidate is the F-104.

The RAAF says it has no particular bias, except that it must obviously buy from a nation which has a big production background and which would beyond doubt stay in the Western orbit. This makes all other nations but the U.S. and U.K. impossible sources of aircraft and equipment. RAAF feels it should have the best of both."

Australia is going to buy C-130 transports as soon as possible. RAAF's reliance on obsolete Dakotas will have to end without delay. RAAF ordered two Convair 440s for its VIP flights, arousing considerable hostility on the part of British makers who were confident that Viscounts would be selected.

No medium bombers to replace Canberras will be bought. It is still planned to buy a small number of V-class bombers—Valiants and Vulcans.

Large orders have been placed for trainers. A number of specially adapted Canberras will be included. DH-115s, manufactured in de Havilland's plant at Sydney, are the main training plane. Complete jet training is advocated by influential RAAF experts.

The Royal Australian Navy Fleet Air Arm is small and suffers from the government's indecision as to what to do with it. It will be strengthened within the next few months when the new light fleet aircraft carrier Melbourne arrives from England. The Melbourne is fitted with steam catapult, angled deck, mirror landing system and the latest arrester gear.

The carrier will be equipped with Sea Venom all-weather jet fighters, turboprop anti-submarine Gannets and Bristol Sycamore helicopters. RAN, unlike the Air Force, is under considerable English influence and is most unlikely ever to buy U. S. planes or equipment.

The future development of Australian military aviation will depend principally on where the Australian personnel is likely to be used and needed. Some experts claim that modern aircraft are not necessarily needed in the South East Asian theater, at least not while likely enemy forces there are without aircraft.

United Kingdom is desperately clinging to the Australian market fearing that what is left of it may also go to U. S. makers. This seems to be the trend now in existence. Australian Air Force in the 1960s will be almost completely equipped with U. S. and Australian built planes which may boast some British engines and parts, built in Australia under license.

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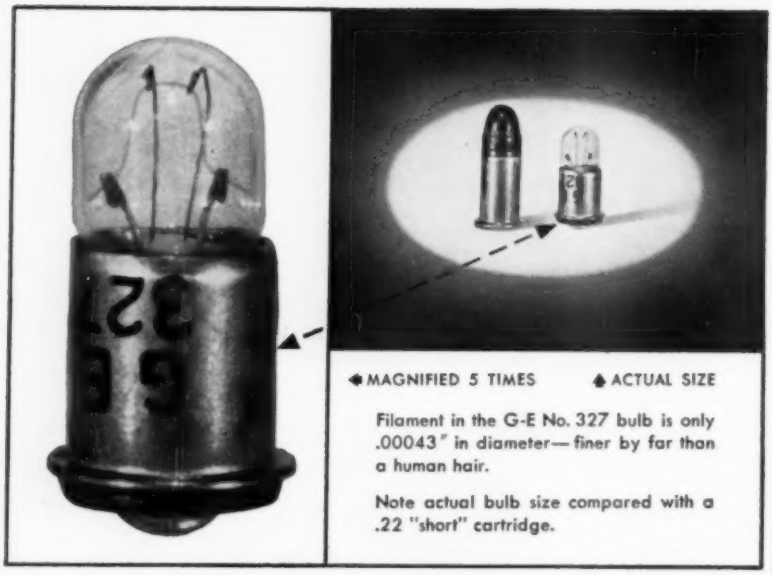

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● BELGIUM

Belgian Air Force Faces Personnel Crisis

Brussels—Belgium will remember 1955 as the year when the latent crisis, both in men and material, in the Belgian Air Force came to the surface.

Defense Minister Spinoy made no attempt in the pre-Christmas debate to deny the formidable indictment of Catholic Deputy Brasseur. The debate brought out that the roots of the crisis certainly dated back to Spinoy's Catholic predecessor Colonel (now General) Degreef.

Spinoy said that many of his officer pilots had war-time RAF training but his technical ground-staff had not. He didn't add that war-trained officers aren't getting any younger, as was shown when an officer of 46 was killed night-flying at the controls of a Meteor II. The fact emerges that organic planning looks for 2,000 officers; and all they've got is 1,350.

The truth seems to be that the Belgian Air Force expanded too fast and too haphazardly. NATO engagements taken in 1953 were beyond the nation's capacity in men, money and material. Economy in maintenance and stocking of spare parts was an unhappy consequence. Regulations have been amended so that the once-in-two-years factory check-up (IRAN) is now done only once in three years.

Deputy Jaminet charged eight pilots in 25 were victims of accidents against one in 25 in the US.

Many repairs and replacement of parts take 18 months, said Brasseur. Grounded aircraft are cannibalized for parts to keep other aircraft in service.

The maintenance delays have especially affected the Thunderjets. What remains of the material of three wings has had to be concentrated in two bases. Meantime the 75 promised Thunderstreaks are on their way, but only 12 have yet arrived.

There is nothing but praise for the Thunderflashes in the Reconnaissance Squadron. Replacement of the Meteor fighters and night fighters is a sore point. Belgium had to let an offshore order for Hawker Hunters slip by. The first Hunter for Belgium had its tests shortly before Christmas; and Spinoy promises the re-equipment of the fighter section by August.

Spinoy has reduced Belgium's NATO commitment, including local defense, from 531 to 439 aircraft. His next step is to see that this smaller number of aircraft, or a reasonable proportion of it, are operational. This may be a tough problem. However, Spinoy has applied a new broom to the generals surrounding him.

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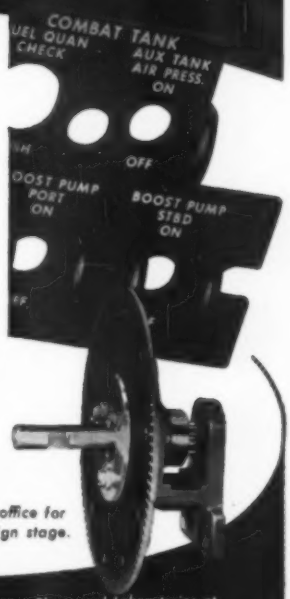

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Brazil Makes Bid For Foreign Industry

Rio de Janeiro—Aircraft production in Brazil is still mostly on paper. But in 1955 some progress was made toward beginning local production.

The Focke laboratory at Brazil's National Aeronautic and Technical Institute, São Paulo, announced a convertiplane being developed especially for use in the Brazilian interior.

Professor Heinrich Focke divides his time between the São Paulo laboratory and his German offices.

The Brazilian Air Ministry believes production of Fokker training planes will begin in 1956 at Galeão Airport.

First trainer will be the Fokker S.11 basic trainer, but the Air Ministry is counting on producing the Fokker S.14 jet trainer.

There is some talk about the possibility of producing the twin-engined Fokker F-27 Friendship airliner. Brazilians call it the only answer to the question of how to make additions to Brazil's DC-3 fleet (173 DC-3s, 45 C-47s).

President Juscelino Kubitschek tried to interest foreign aircraft manufacturers to start production in Brazil while on his recent trip to U. S. and Europe. So far, the manufacturers showing the most interest have been in England, France and Germany.

The newest addition to Brazil's Air Force arrived in January. The addition consisted of 12 C-82 Flying Boxcars, which will be used by the Brazilian Air Force for parachute training and cargo runs. FAB (Fôrças Aéreas Brasileiras) received 25 F-47 Thunderbolts in 1955 and 72 Gloster Meteor jets in 1954.

Brazil is looking to European plane manufacturers for new military aircraft. But sales of older U.S. aircraft could increase in the next three years (example: recent purchases of F-47 Thunderbolts and C-82 Boxcars). Fifty sergeants have returned from U.S. Air Force maintenance training in Panama. A new group of Brazilians will be joining the Latin-American Hemisphere Command in Washington.

Norway Stresses Fighter Defense, Uses Thunderjet

Oslo—The Norwegian Air Force is based on fighter defense. To that end the Air Force by the end of 1956 will have 8 squadrons, most of them equipped with F-84 Thunderjets.

Late in 1955 the Air Force received its first F-86K night fighter, and more will be delivered in the near future. In addition NAF has one jet training squadron equipped with T-33s, a transport squadron of C-47s, most of which will be replaced in 1956 by C-119s.

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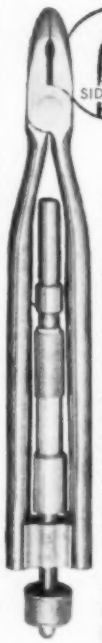

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Holland Steps Up Production Output

Amsterdam—Production of aircraft in Holland now centers in the Royal Netherlands Aircraft Factory Fokker at Schiphol following the acquisition in 1954, of the Avio-Diepen Works of Ypenburg and the aircraft division of the shipyard, De Schelde.

In the past year, production included:

- **Fokker S.14** Mach-Trainers for Royal Netherlands Air Force.
- **Four prototypes** of the turboprop F-27 Friendship airliner of which two are for test flying. Fairchild Engine & Airplane Corp. will begin to build them under license.
- **Quantity production** of Hawker Hunter jet fighters.
- **Repair and overhaul** of Gloster Meteor, Republic F-84 Thunderjet jet fighters and C-47s.

In the course of 1956 a new large production plant for metal bonding and reinforced plastics will be completed.

No figures are available for orders on hand at the end of 1955. At the end of 1954, orders in execution totaled $6.2 millions. Employment at Fokker increased from 4,000 to 4,800.

At the beginning of 1956, there were 6 day fighter squadrons, 3 all-weather squadrons, 6 tactical squadrons, 1 transport squadron and 1 reconnaissance squadron.

The Tactical Air Command operates together with the Belgian Tactical Air Command, forming No. 83 Group within II ATAF under operational control of AIRCENT (NATO). Conversion from Republic F-84G Thunderjets to sweptwing F-84F Thunderstreaks is in full swing.

Air Defense Command squadrons are still equipped with the Meteor F-8, but very soon the new Hawker Hunter will have taken over. After the three squadrons of F-86K single seat all-weather fighters have arrived, 15 Royal Netherlands Air Force operational squadrons will be transonic.

The Reconnaissance squadron will be re-equipped with the RF-84F sweptwing Thunderflash soon.

The Naval Air Service at home consists of:

- **Light Fleet Aircraft Carrier Karel Doorman.** It is temporarily out of commission for refitting with an angled deck and steam catapult. Re-commissioning is expected in 1957. The carrier will be equipped with 30 British Hawker Sea Hawks, supplied under the U.S. off-shore procurement program.
- **Seven squadrons:** Grumman Avengers, Hawker Sea Furies, Beechcraft, Sikorsky, Consolidated Vultee Catalinas, Martin Mariners and Lockheed Neptunes.

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CAA Acts to Improve Air Traffic Control

CAA's Lowen outlines steps at ALPA safety forum; air traffic control office to be given elevated status.

Chicago—The Civil Aeronautics Administration is taking four steps to meet "a growing demand for an action program to maintain order on the skyways," CAA Administrator Charles J. Lowen told the Air Line Pilots Association's Fourth Annual Safety Forum here last week.

These steps are, he said:

• **Elevation of the Office** of Air Traffic Control to "the status of a separate office." It is now a part of the Office of Federal Airways, which also has responsibility for engineering, maintenance and inspection of air navigation facilities. The shift, Lowen said, will "give the traffic control group all the prestige and power they need . . . to get things done" and will "reverse completely the approach of having the operations of the air traffic control system governed by the kind of tools the engineers give the operators."

Lowen said it "seems to me more logical that the men who have to operate the system should develop broad performance specifications for the equipment they need, and that then the engineers should apply their ingenuity and skill to devising and perfecting such equipment."

Acting director of the new office, Lowen said, will be David D. Thomas.

• **Acquiring a B-47** and later a Boeing 707 or Douglas DC-8 for simulated jet airline runs in order to gain "more direct and intimate knowledge of jets before they go into civil use some three years from now."

• **Installation of an** IBM data processing machine and printer at its Indianapolis Air Route Traffic Control Center. Lowen said that SAGE "offers no immediate answer to a pilot's prayer." There is only one SAGE setup—the prototype in the Boston area—and SAGE "will require extensive revision to accomplish the air traffic control mission of directing a considerable number of planes away from one another," he said. In the meantime, CAA will try out the IBM Magnetic Drum Data Processing Machine to "get our feet wet in the computer field" and "find out if it furnishes an acceptable means of mechanizing the essentially clerical duties of the controller, freeing him for his more significant responsibilities of analysis and decision-making."

• **Installation of 69 long-range** radars by 1961, "of which 18 should be provided for next fiscal year." In addition to new radar, CAA has "launched an intensive program for testing a tie-in of Air Defense Command radar to our Indianapolis Air Route Traffic Control Center. This will be supplemented by joint activity in the Boston area." Lowen said the new radar is "the essence of our 5-year plan," which is still under study in Congress. The five-year plan also calls for 383 additional omniranges "for our growing volume of general aviation."

"As we get these radars and an accompanying expansion in communications capacity, we can provide complete control of the airspace starting in the higher altitudes," Lowen said. "This is something the military needs immediately, and that you (the pilots) will need in the near future for jet operations."

Lowen said he believes "American public opinion is awakening to the urgency of the problem" of air traffic control and that "we are going to get the tools we need to meet this great challenge."

He said it should be "realistically recognized that this nation can buy whatever degree of traffic control it is willing to pay for."

CHARLES J. LOWEN

Dr. Furnas to Stay, Wilson Says

Washington—Secretary of Defense Charles E. Wilson said there has been "considerable misunderstanding" about his Feb. 21 memorandum shifting responsibility from the office of Assistant Secretary of Defense for Research and Development Dr. Clifford C. Furnas to Assistant Secretary of Defense for Applications Engineering Frank D. Newbury (AW Mar. 5, p. 27).

Wilson said the transfer, widely interpreted in Pentagon R & D circles and elsewhere as a blow to the nation's military R & D efforts, was "an effort to clarify some responsibilities as between the research, the development and production for use."

He denied that Dr. Clifford C. Furnas submitted an unsigned letter of resignation, saying Dr. Furnas had written him "a memorandum about it."

Wilson left town shortly after the transfer of responsibilities was announced.

He explained the "misunderstanding" this way:

"Unfortunately, I suppose it was partly my fault. I have got so many balls in the air all the time I am anxious to get some of them down, and I was going to go away on a short vacation so I just operated a little fast and didn't do the usual job of explaining in detail and doing a little selling. . . ."

Wilson made his remarks on the controversy during a Pentagon press conference.

Wilson said he has talked with Dr. Furnas since the latter wrote the memorandum. Asked if Dr. Furnas now "is satisfied with your selling job," Wilson replied:

"Well, I wouldn't like to brag about my selling abilities. He is a very fine, understanding man. I think very highly of him, and I am very pleased he is down here."

Dr. Furnas, in turn, was not in Washington at the time that the press conference took place and could not be immediately reached for comment on Mr. Wilson's comments.

Convair Will Build Short-Haul Jet Airliner

San Diego—Convair Division of General Dynamics Corp. announced plans last week to build an 80-passenger, medium-range (2,000 mi.) jet transport for delivery in 1960.

Designated the Model 22, the aircraft will be designed for a 580 mph. cruising speed and carry an expected market price of $3.5 million. Power will be supplied by four General Electric J79 turbojets derated from their present 15,000 lb. thrust to 9,000 lb.

Maximum takeoff weight called for in the design is 170,000 lbs.; design empty

CF-100 Mark 5

Avro Aircraft Ltd.'s new version of its CF-100 all-weather fighter, the CF-100 Mark 5 (above), has a three-foot extended wing and a modified tailplane for increased high-altitude (50,000 ft.) performance. The Mark 5 is now going into production for the RCAF.

weight, 72,500 lbs. The transport's wingspan will be 118 ft., with both the wing and tail surfaces swept back at an angle of 35 degrees.

The length will be approximately 118 ft. Its landing gear will consist of four wheels on each main strut and two on the nose wheel. Landing roll is expected to be less than that of the larger Douglas DC-8 jet transport but longer than that of the DC-7.

Specifications call for a crew of two pilots, a flight engineer and two stewardesses. Passenger entrances will be provided at both the front and rear of the fuselage on first-class and coach versions.

The latter version will carry a maximum of 99 passengers.

The first prototype is scheduled to be ready for flight testing late in 1959.

House Unit Trims NACA Budget by $5.2 Million

Washington—The House Appropriations Committee has clipped $5.2 million off National Advisory Committee for Aeronautics' Fiscal 1957 budget.

The $74,475,000 voted by the committee compares with the $72,700,000 budget for Fiscal 1956.

The committee cut the allocation for salaries and general administrative expenses from the $64,700,000 recommended in the President's budget to $61,475,000 with the explanation that "the agency has experienced considerable difficulty in filling scientific and technical positions and the amount provided is a substantial increase for Fiscal 1957 and is expected to provide the full amount that will actually be required."

The committee declared that construction costs "can be reduced." It cut NACA's proposed budget of $15,444,000 for eight new projects to $13,000,000.

Profits Investigation to Hear Services, Renegotiation Board

Washington—Testimony of Air Force, Navy and Renegotiation Board witnesses before the House Armed Services Investigating Subcommittee is expected to highlight the different standards applied by the three agencies in considering profits on military aircraft contracts.

The subcommittee, headed by Rep. Edward Hebert (D.-La.), completed testimony last week from the 12 major airframe manufacturers in its investigation of the financial status of the industry, which is primarily sustained by government business. After hearings with service and Renegotiation Board witnesses, the subcommittee plans a series of visits to the plants of the 12 manufacturers.

Developments during the appearances of Republic Aviation Corp., Chance Vought Aircraft and Lockheed Aircraft Corp. were:

• **Hebert declared** that Republic "was a failure at all times except when rescued by military business. . . . It has not been profit-making except as a government subsidiary." Organized in 1931, the firm was not successful until it obtained World War II business. After a post war depression the company's business turned upward with the F84 contract. It was developed, however, that if Republic had not been a going concern, it would have taken three years—instead of 18 months—to get the first F84 fighter off the line for the Korean emergency.

• **Chance Vought, organized** as an independent firm in 1954, was criticized for an advertising bill of over $1 million chargeable to government contracts. Observing that stock speculation is beyond management control, Hebert declared that the price of aircraft stocks "is being held up by the cold war or defense production." From an original sales price of $22 a share in 1954, Chance Vought stock has risen to approximately $40.

• **Lockheed was singled out** as an aircraft company that demonstrated itself "as a successful commercial manufacturer," by Hebert and other committeemen. In 1955, 20% of Lockheed's business was commercial.

Details developed on the three firms were:

• **Republic.** Government sales accounted for 99.5% of total business in 1952; 97.6% in 1953; 99.2% in 1954; and 99.9% in 1955. Net worth increased from $19 million in 1952 to $42.8 million in 1955. Over this period, paid-in capital increased from $1.9 million to $13.8 million and surplus retained increased from $15.9 million to $27.5 million.

• **Chance Vought.** Government sales accounted for 99.9% of business in 1954 and 1955. Paid in capital of the firm increased from $17 million to $26 million. Earned surplus amounted to $8.8 million in 1955. Net worth of the company was set at $26 million.

Lockheed. Government sales accounted for 91.4% of total business in 1952; 93% in 1953; 84.4% in 1954; and 80.9% in 1955. Paid-in capital increased from $11 million in 1952 to $26 million in 1955 and surplus retained in the business increased from $42 million to $68.9 million. Net worth of the company mounted from $55 million in 1951 to $97.7 million in 1955.

Aircraft Sales and Profits Show Slight Drop From Post-War Peak

Net income of $65.6 million reported by four major aircraft manufacturers on sales totalling $1.699 billion indicates that the trend of 1955 sales and profits will be slightly under the post-war records reached in 1954 but still higher than any other previous post-war year.

United Aircraft Corp.

New peaks in profits and sales were recorded by United Aircraft Corp. in 1955 with net income of $31,064,924 on sales of $679,921,704. This compares with profit of $25,996,232 on sales of $654,239,961 in 1954. Earnings were $6.14 per common share after preferred dividends compared with $5.10 in 1954.

Pratt & Whitney division of UAC revealed it had delivered more than 3,000 J57 turbojets and had developed this engine's power to well beyond its original 10,000-lb. thrust figure. Hamilton Standard division is now devoting about 30% of its floor space to production of its accessory products line supplementing propeller production. A major expansion program is scheduled at Hamilton in 1956. Sikorsky Helicopter increased its employment by 60% to a total of 8,400 employes on S-55 and S-58 production, with first deliveries of the twin engine S-56 made late in 1955. UAC reported its 1952 business had been cleared by the Renegotiation Board and no refunds were anticipated for 1953-55 business. Backlog was $1.4 billion.

Boeing

Net income of $30,391,411 was reported by Boeing Airplane Co. for 1955 on sales of $853,827,722. This is a decrease from profit of $36,976,023 on sales of $1,022,676,265 for 1954. Final 1954 profit has been cut to $31 million by a $5 million allowance for possible renegotiation refunds. Boeing has allowed a total of $8,746,702 for possible renegotiation refunds for 1953 and 1954 extracted from earnings retained for use in the company. Boeing President William M. Allen said he felt that no renegotiation refunds would be required on 1955 business. Boeing is currently appealing in the U. S. Tax Court the Renegotiation Board claim for 1952. Boeing now has a backlog of $2,624 million, of which $351 million represents commercial jet transport orders.

Temco

Peak profits in its 10 year history were reported by the Temco Aircraft Corp. for 1955. Temco had a net income of $3,103,000 in 1955 on sales of $78,224,390. Sales jumped 32% over the 1954 figure of $59,209,000. Temco has a $96 million backlog.

Ryan

Net income of $1,550,590 was reported by Ryan Aeronautical Co. for 1955 compared with $1,961,667 for 1954. Sales totalled $41,527,770 for 1955 compared with $45,155,287 for 1954. Ryan boosted its backlog from $36.9 million in 1954 to $55 million.

Xron-1 Rotocycle

Navy's Xron-1 rotocycle is shown above during initial flight tests by its manufacturer, the Gyrodyne Co. of America, Inc., St. James, Long Island, N. Y. The rotocycle, which has counter-rotating rotor system, can be folded into small package for storage or transportation.

ATA President Urges Independent ANDB

Washington—The Air Transport Assn. has urged that the Air Navigation Development Board be strengthened and given independent status to cope with the acute problem of air traffic congestion. (For a discussion of the problem, see p. 240.)

In testimony before the Senate Commerce Aviation Subcommittee, headed by Sen. Mike Monroney (D.-Okla.), ATA President Stuart Tipton said the ANDB "should consist of the Secretary of Commerce, the Secretary of Defense and a full-time chairman independent of both departments to be appointed by the President with the advice and consent of the Senate."

Tipton said the present ANDB is ineffective because it depends on agreement by Commerce and the Defense Department for implementation of its decisions and "military and civil aviation are too frequently conflicting to permit representatives of each to agree upon long-range solutions."

Tipton also objected that ANDB has approached the problem of air traffic control "in reverse." Its staff has been assigned to evaluate specific equipment for possible use in traffic control. "The system should be planned first," he declared. "Only then should time and effort be devoted to evaluation of individual pieces of equipment."

The ATA president opposed separation of the Civil Aeronautics Administration from the Commerce Department, as proposed by Sen. Monroney, on the grounds that this would mean loss of cabinet-level representation for civil aviation. He told the subcommittee that 10 of ATA's 11 directors supported this position, and one took no position. In a poll of members, he said, 20 opposed separation of CAA from Commerce, three favored it, and five took no position.

Navy, Westinghouse, McDonnell Blamed in 'Demon' Probe Report

Washington—A Congressional committee points the finger at the Navy Department, Westinghouse Electric Co. and McDonnell Aircraft Corp. to "share the responsibility for errors of judgment and waste of public funds" in the "Demon" fighter program.

The report by the House Government Operations Committee is based on investigations and public hearings held last October by its Subcommittee on Military Matters, headed by Rep. Chet Holifield (D.-Calif.).

The Navy spent more than $500 million for 280 F3H aircraft, built by McDonnell and powered with the Westinghouse J40 engine. Of these, the first 60 (excepting four backfitted with J71 engines) will be limited to nonflying uses. Pointing out that the remaining 220 planes have not yet been tested in fleet use, the report declared that "the expenditures in the aggregate were excessive when judged by the end results."

The primary recommendation of the committee was that the responsibility of airframe manufacturers, under Navy contract, should be increased to provide for the "package" delivery of finished units—frame, engine, components. The basic cause for the failure of the "Demon" program was an engine underpowered to support the airframe.

Although the Navy has taken "some steps" to increase airframe manufacturers' responsibility, the committee declared that BuAer's program is still "characterized by dispersion of responsibility and by disjointed relationships among the engine manufacturer, the Navy, and the airframe manufacturer. . . . Responsibility should be centered in the airframe manufacture for procurement of engines and other aircraft components."

The committee also hit at undesirable inter-service competition for aircraft production. Air Force priorities on the J71 engine prevented its early installation in the F3H. The committee said it "senses a costly and overzealous competition between the Air Force and the Navy for control of aircraft production resources, notwithstanding the apparent cooperation through plant cognizance programs. . . ."

The Navy attitude of "resignation to the inevitability of frequent failures in development and 'slippages' in production and the fear that the enforcement of penalty clauses in contracts will discourage technological progress" also was criticized.

The committee called on the General Accounting Office to make a study of military termination practices and to "evaluate the extent to which the government's interests are jeopardized by failure to exercise default privileges." All of the cancelations in connection with the "Demon" program were "at the convenience of the government," involving contractor protection.

The committee said it "makes no charge of impropriety in the strict legal sense" concerning McDonnell's employment of Adm. Lloyd Harrison promptly upon his retirement as Deputy Chief of the Bureau of Aeronautics. But the committee observed "the tendency of large industrial firms to recruit retired military officers, which enlarges the possibilities for official actions to be shaped by their effect upon prospective employment in industry." It was recommended that the Secretary of Defense review laws and regulations regarding employment of retired military personnel in industry.

New Demon Order

The U. S. Navy last week announced a $55 million order for late-model McDonnell Aircraft Corp. Demon fighters.

The order, placing McDonnell's backlog at an all-time high of $622 million, is divided between the all-weather F3H-2N and the missile-carrying F3H-2M. Both versions are powered by Allison J71 turbojets. Six F3H-2N fighters completed the Navy's fleet introduction program at the Naval Air Test facility at Patuxent River, Md. The program involved 364 flights. McDonnell says the F3H-2N is "the fastest all-weather fighter now in Navy service."

Probe of Airline Fares Is Suggested by Rizley

Washington—Ross Rizley, outgoing chairman of the Civil Aeronautics Board, proposed a Board investigation of the airline passenger fare structure in testimony before the House Anti-Monopoly Subcommittee headed by Rep. Emanuel Celler (D.-N. Y.).

Rizley pointed to numerous decisions during his year as chairman as having "substantially broadened the operating authority of both the domestic and international air carriers, making important new and improved air services available to the public and materially increasing competition among the carriers." He said there now is competitive air services between 44 of the 50 top-ranking pairs of traffic points in the U.S.

Atomic Progress

Pratt & Whitney Aircraft's atomic engine will be used in a Lockheed airframe, United Aircraft Corp. revealed in its annual report. Since its inception in 1952 the P&WA atomic engine development had been linked to a Boeing airframe design.

The UAC announcement indicates a shift in Air Force planning with a possibility that Boeing may be devoting its major effort to its Project 110 chemically fueled supersonic bomber.

UAC also revealed that the P&WA atomic project has expanded to include installations at the Atomic Energy Commission's Livermore, Calif., and Oak Ridge, Tenn., laboratories. The main atomic engine development laboratory now under construction near Middletown, Conn., will be completed in 1957 and eventually employ 3,000 engineers, scientists and technicians.

Talos to See Service In Defense Command

Washington—The ramjet-powered Talos surface-to-air missile (AW Jan. 16, p. 37) will go into service with the Continental Air Defense Command—initially aboard the light cruiser U.S.S. Galveston and at four Air Force sites in the Midwest.

The Galveston will be converted to a guided missile ship and further funds have been requested for additional light cruisers to carry the Talos.

Air Force survey teams soon will make studies of sites at Lockbourne AFB, Ohio; Bunker Hill AFB, Ind., and others near Peoria, Ill., and Kirksville, Mo.

Defense Department said land use of the Talos "will not affect the role and use of Nike," the Army anti-aircraft guided missile now guarding many American cities.

Defense said "detailed capabilities" on Talos "are not releasable." As noted earlier in AVIATION WEEK (Jan. 16, p. 37) the Talos is the integrated result of two successful developments originating in the Navy Bureau of Ordnance's Bumblebee missile program—a supersonic ramjet engine designed for speeds above Mach 2 and controlled in its flight path by a highly developed fuel system; and a supersonic beam-rider missile, the Terrier, now going into Atlantic fleet service on the U.S.S. Boston.

Bendix Aviation Corp.'s missile division is the prime contractor and McDonnell Aircraft Corp. builds the airframe. Farnsworth Division of International Telephone and Telegraph is building the internal guidance equipment.

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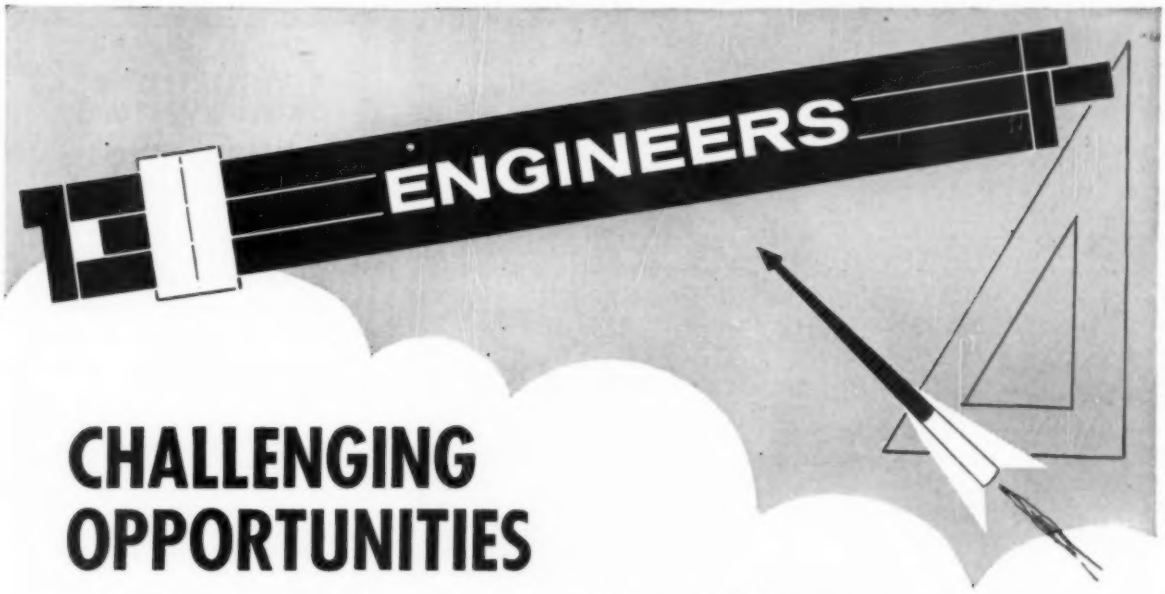

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- Weapon Systems Engineer to join guided missile project staff. Will work on over-all systems problems associated with ground or air based missile systems. Such problems include: missile aerodynamics, propulsion, performance and control. Will conduct and supervise missile preliminary design investigations. Will also prepare and coordinate wind tunnel test program on missile and missile components.

- Structural Research Engineer to apply and develop structures theory for the prediction of structural integrity of airborne vehicles under high heat loading conditions. The problems involved deal with flight speeds in the hypersonic range where the "thermal barrier" is encountered.

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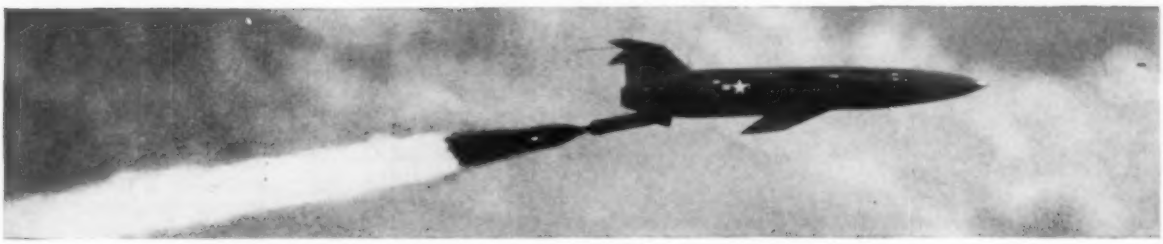

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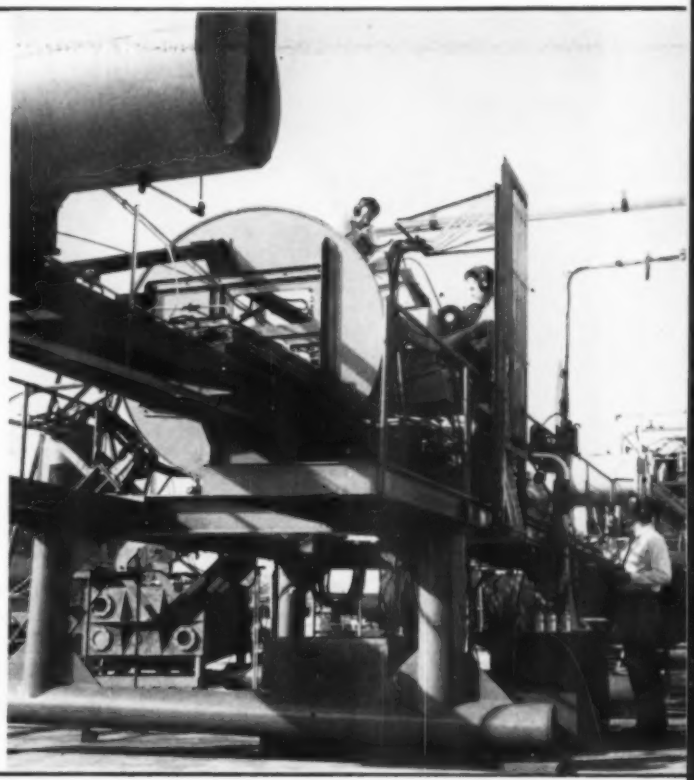

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P-1037, Aviation Week
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P-9214, Aviation Week
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P-1034, Aviation Week
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ENGINEERS

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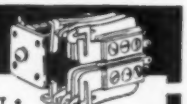

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268	2600-20	Wright
4	3350-57	Wright

Quantity	Part No.	Description
6	83A94	Heater
2	C97A49	Heater
7	C97A28	Heater
150	921-8	Heater
21	MF45-3911-20Z	Pump
120	MF9-713-15H	Pump
124	PF12-713-25BCE	Pump
6	610-2C	Pump
76	TFD 8600	Pump
21	2E258 SA	Pump
508	D7818	Pump
20	36001-1C-3-A1	Magnetic Dual Compass
40	10078-1-AG-A1	Gyro Indicator
134	3801-3B	Fuel Quan. Gauge
200	222-1F-2A	Tachometer Indicator
12	15701-1A	Trim Tab Controller
64	CQ-9	Switch
1	15003-1-C	Gyro Flux Gate Transmitter
100	NEA3	Generator
71	1003-4	Generator
393	564-2A	Oil Separator
13	2227-11-D3A	Dual Electric Tachometer
29	NEF-2	Aux. Power Unit
20	LER30D	Aux. Power Unit
130	612-4A	Valve
53	48362	Shaft
75	48363	Shaft
111	84487	Housing
1475	48360	Bearing
2	TFD 1130C	Pump
261	7909	Cylinder Assy.
88	10974	Cylinder Assy.
3	TFD28000-1	Pump
32	50033	Switch
20	M101B	Switch
349	M826	Switch
93	4401W	Switch
59	AN5831-1	Switch
70	NAF1195-20	Switch
50	P4CA-2A	Primer
5	67WF300-1	Pump
2	67WF300	Pump
2	167WH200	Pump
19	753A	Sonobuoy
50	AN6203-1	Accumulators
40	AN6203-3	Accumulators
56	AA14002A	Accumulators
11	AA14007A	Accumulators
384	564-2A	Oil Separator
140	612-4A	Oil Separator
52	572-3A	Valve
26	MS49A	Antenna Switch
959	NF10084	Noise Filter
740	1C200	Noise Filter
1459	37D6210	Oil Dilution Valves
17	AN4014	Wobble Pumps
261	1033	Control Switch
22	A55A00	Ignition Unit
9	366-2LH	Seats
12	366-2RH	Seats
700	146414	Tail Wheels
161	490D4	Actuator
159	490EC	Actuator

Quantity	Part No.	Description
12	189W	Actuator
6	1648T-2	Actuator
2	400 JE	Actuator
3	11 KJ	Actuator
10	R170-M1	Actuator
22	550DJ	Screw Jack
19	550EN	Screw Jack
6	557P	Screw Jack
40	733A	Coupling
11	732A	Coupling
38	761A	Coupling
10	AN5771-4A	Hyd. Gauge
28	AN5771-4	Hyd. Gauge
52	47824	Indicator
102	11108	Oil Gauge
17	EA143	Fuel Indicator
148	8TJ9-PXK	Transmitter
246	B4788	Light Fixture
274	B4756-80	Light Fixture
138	B4755	Light Fixture
64	A4255A	Instrument Light
9	CO50A	Blower
3	A28A8640	Blower
5	AFB129-100	Blower
358	2301 ON	Thermostat
126	17322-2	Thermoswitch
20	18522-0	Thermoswitch
22	17343-6	Thermoswitch
22	18422-0	Thermoswitch
49	715E	Temperature Control
111	10-55085-1	Filter Unit
78	AN3155-25-100	Rheostat
129	AN3155-50-100	Rheostat

Quantity	Part No.	Description
15	EA15W4147504-1	Tank Units
46	UC635A	Fuel Strainers
66	AN4000-2B	Fuel Strainers
170	11749	Receptacle
311	11751	Plug
228	1V40-550	IRS Valve
133	AN3320-1	Relay
146	AN3316-2	Relay
48	254BK-6-052	Diff. Pressure Gauge
4	X836-1C2D	Blades
32	AN6018-1	Valve
27	AN6200-8A	Valve
340	AN6207-8	Valve
567	AN6207-12	Valve
140	AN6209-4D	Valve
131	AN6209-8	Valve
50	AN6213-2	Valve
14	AN6245-AB4	Valve
207	AV1B1174	Valve
81	AA14543	Valve
12	34583	Valve
19	AA14503	Valve
13	AA13021	Valve
10	AA11504	Valve
16	AA11435	Valve
125	20501-3	Valve
25	13956	Valve
14	13904	Valve
498	AA17001A	Valve
106	12924-2	Valve
140	612-4A	Valve
12	403196-0-1	Valve
30	401856-3	Valve

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16	30686	Wave Guide
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139	MT6	Transformer
120	5103112-003	Timer
148	TOL-4A	Oscillator
407	SF9-LN2	Magneto
4	180011-1	Water Separator
22	417	Actuator
273	AN6220-4	Coupling
419	450	Filters
12	46B361	Compensator
8	BC733D	Receiver
17	PY4M	Q.E.C. Unit
500	NF3-5	Filter
425	5BA40NJ1A	Motor
189	5DP65-MB1	Motor
44	5BA25D-J4B	Motor
21	FD65-5	Motor
465	417033	Crank Case
16	CNX-11	Relay
40	4811-14-1	Gear
12	EA15-11	Tank Units
8	EA15A82-00128-2	Tank Units
9	EA15A82-00128-3	Tank Units
20	EA15AWC	Tank Units
34	EA15W3-14659	Tank Units
17	EA15AW263661	Tank Units
16	EA15A-F-263662	Tank Units

70	401561-2	Valve
620	PL2-2546-77	Valve
345	1-1741-39	Valve
354	7-1343-5	Valve
196	PL9-2740-9	Valve
179	3-1140-20A	Valve
193	3-1241-2	Valve
105	SP4-2746-78	Valve
52	709-CG12	Valve
122	709-CG6-6D	Valve
65	8-334-6	Valve
237	9696	Valve
814	74247	Valve
7	74345-2	Valve
7	74365-1	Valve
9	84324	Valve
8	94058	Valve
15	M1670-M1	Gear Box
24	HC2109	Hyd. Cylinder
9	HC2110	Hyd. Cylinder
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4	12.50X16	Wheel
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371	5QD1800B	Drop Tank Valve
132	8QD1800B	Drop Tank Valve
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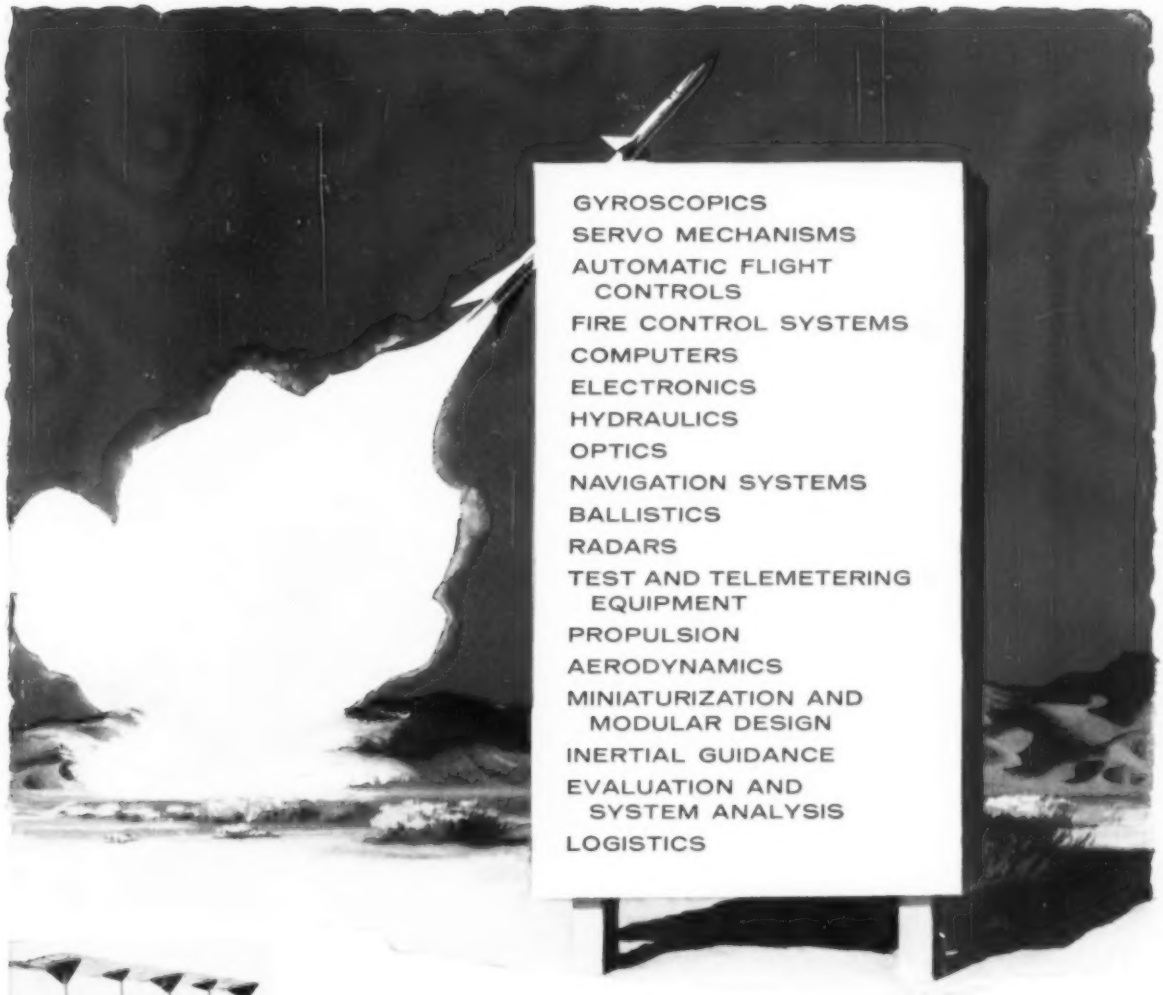

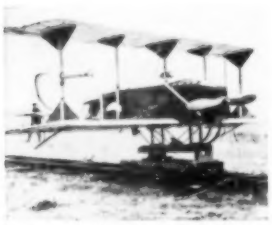

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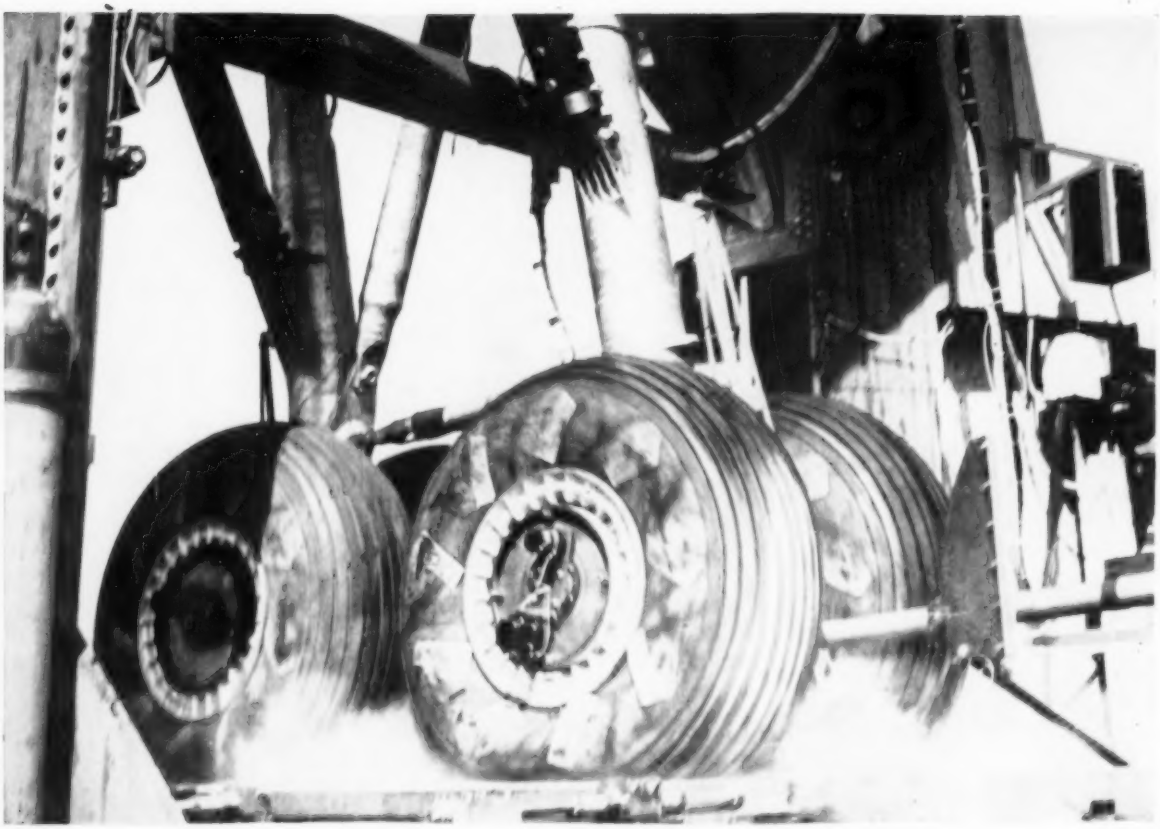

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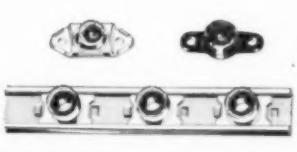
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